Attachment C
ITSF13000704/CD
Muni Ways & Structures Facility
100kW Solar Electric Project

Muni Maintenance Facility: Building A
700 Pennsylvania Avenue, San Francisco, CA

I. Attached Documents

A. Construction Drawings

B. PV Modules & Racking (SOLON Solquick)

C. Eco Fastener Info

D. Combiner/Recombiner Cut Sheet

E. Inverter Cut Sheet

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 PENNSYLVANIA AVENUE, SAN FRANCISCO, CA 94114

APPLICABLE CODES AND STANDARDS

1. 2010 CALIFORNIA BUILDING CODE (CBC), VOLUMES #1 AND #2 (PART 2, TITLE 24, CCR)
2. 2010 CALIFORNIA ELECTRICAL CODE (PART 3, TITLE 24, CCR)
3. 2010 CALIFORNIA MECHANICAL CODE (CMC) (PART 4, TITLE 24, CCR)
4. 2010 CALIFORNIA PLUMBING CODE (CPC) (PART 5, TITLE 24, CCR)
5. 2010 CALIFORNIA ENERGY CODE (PART 6, TITLE 24, CCR)
6. 2010 CALIFORNIA FIRE CODE (CFC) (PART 9, TITLE 24, PART 9)
7. SOLAR PHOTOVOLTAIC INSTALLATION GUIDELINE: OFFICE OF THE STATE FIRE MARSHAL, DATED APRIL 23, 2008
8. OSA-18-10-B SOLAR PHOTOVOLTAIC AND THERMAL SYSTEMS REVIEW AND APPROVAL REQUIREMENTS, REVISED 01-06-2012
9. ASCE 7-05 MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES

SCOPE OF WORK

PROJECT TO INSTALL A 100 KW PHOTOVOLTAIC (PV) SYSTEM AT 700 PENNSYLVANIA AVENUE, AT THE MUNI WAYS AND STRUCTURES FACILITY. THE PV MODULES WILL BE SOLON SOLOLUCH UNITS WHICH WILL BE POSITIVELY ATTACHED (ANCHORED) TO THE MAIN BUILDING ROOF. THE MAIN BUILDING ROOF WILL BE RECOVERED WITH A NEW MEMBRANE ROOF PRIOR TO PV INSTALLATION.

ELECTRICAL OUTPUT (DC) WILL BE ROUTED VIA CONDUITS TO AN INVERTER (TO CONVERT DC POWER TO AC POWER) TO BE LOCATED IN ROOM A114. THE OUTPUT AC POWER WILL BE FED TO THE FACILITIES MAIN ELECTRICAL SWITCHBOARD IN ROOM A113 VIA A LINE SIDE ELECTRICAL CONNECTION.

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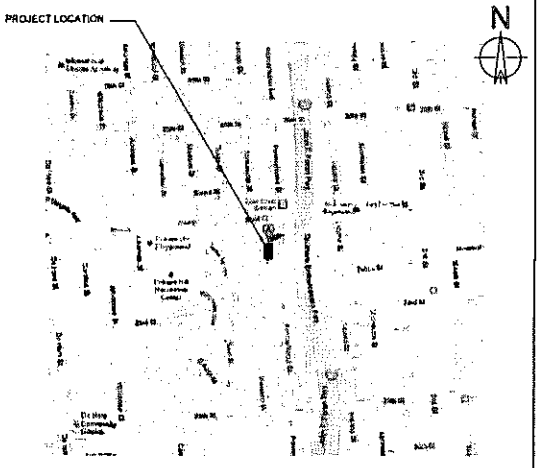
VICINITY MAP



PROJECT TEAM

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AEPC Group, LLC

TM

TRS

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SDS REVIEW	3/1/13	A

SHEET INFORMATION
Date 2/22/2013
SFPUC-13008
None
SDS
Checked by AR/AM

TITLE SHEET

SHEET
T0.1

SITE PLAN

SCALE: N.T.S.

N

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SITE PLAN

T0.2

GENERAL NOTES

1. GENERAL

A. ALL CONSTRUCTION MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE CALIFORNIA CODE OF REGULATIONS, 2010 EDITION (CCR), AND SAN FRANCISCO BUILDING CODE, 2010 EDITION.

B. THESE NOTES APPLY TO ALL STRUCTURAL DRAWINGS AND GOVERN UNLESS OTHERWISE NOTED OR SPECIFIED.

C. VERIFY ALL EXISTING CONDITIONS AND PROPOSED DIMENSIONS AT JOB SITE. COMPARE STRUCTURAL DRAWINGS WITH OTHER DISCIPLINE DRAWINGS BEFORE COMMENCING WORK. NOTIFY ENGINEER OF ANY DISCREPANCIES AND DO NOT PROCEED WITH AFFECTED WORK UNTIL THEY ARE RESOLVED. DO NOT SCALE DRAWINGS. WHERE THERE IS A DISCREPANCY IN THE DRAWINGS, THE CONTRACTOR IS TO INCLUDE IN HIS BID THE MORE EXPENSIVE VERSION.

D. UNLESS OTHERWISE SHOWN OR NOTED, ALL TYPICAL DETAILS SHALL BE USED AT SIMILAR CONDITIONS.

E. SAFETY MEASURES: AT ALL TIMES THE CONTRACTOR(S) SHALL BE SOLELY AND COMPLETELY RESPONSIBLE FOR THE CONDITIONS OF THE JOB SITE INCLUDING SAFETY OF PERSONS AND PROPERTIES, AND FOR ALL NECESSARY INDEPENDENT ENGINEERING REVIEWS OF THESE CONDITIONS (EXAMPLE: SHORING). DRAWINGS AND SPECIFICATIONS REPRESENT FINISHED STRUCTURE. CONTRACTOR SHALL BE RESPONSIBLE FOR MEANS AND METHODS OF CONSTRUCTION. THE CONTRACTOR SHALL TAKE ALL NECESSARY MEASURES TO ENSURE SAFETY OF ALL PERSONS AND STRUCTURES AT THE SITE AND ADJACENT TO THE SITE; OBSERVATION VISITS TO THE SITE BY THE ENGINEER OR CONSTRUCTION MANAGER SHALL NOT RELIEVE THE CONTRACTOR OF SUCH RESPONSIBILITY. SITE VISIT ARE NOT INTENDED TO REVIEW THE ADEQUACY OF THE CONTRACTOR(S) SAFETY MEASURES.

F. OMISSIONS OR CONFLICTS BETWEEN VARIOUS ELEMENTS OF THE DRAWINGS, NOTES, AND DETAILS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER AND RESOLVED BEFORE PROCEEDING WITH THE WORK.

G. DO NOT USE SCALED DIMENSIONS; USE WRITTEN DIMENSIONS. WHERE NO DIMENSION IS PROVIDED, CONSULT THE ENGINEER FOR CLARIFICATION BEFORE PROCEEDING WITH THE WORK.

H. IF CERTAIN FEATURES ARE NOT FULLY SHOWN OR CALLED FOR ON THE DRAWINGS OR SPECIFICATIONS, THEIR CONSTRUCTION SHALL BE OF THE SAME CHARACTER AS FOR SIMILAR CONDITIONS THAT ARE CALLED FOR OR SHOWN.

I. REQUIRED WORK SHALL INCLUDE, BUT IS NOT NECESSARILY LIMITED TO, WORK CALLED FOR BY NOTES ON BUILDING FLOOR PLANS WHILE THE DRAWINGS INDICATE ITEMS TO BE REMOVED, REPLACED OR REMODELED, THEY MAY NOT NECESSARILY INDICATE ALL ASPECTS OF WORK REQUIRED. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO FURNISH AND INSTALL ALL WORK NECESSARY TO COMPLETE AND FINISH ALL AREAS IN AND AROUND SUCH ITEMS.

J. THE GENERAL CONTRACTOR MUST CAREFULLY SCRUTINIZE ALL DRAWINGS TO ASCERTAIN ALL REQUIRED WORK ARISING OUT OF WORK DONE BY MECHANICAL, PLUMBING, ELECTRICAL OR OTHER SUB-CONTRACTORS.

K. THE CONTRACTOR SHALL MAKE EVERY EFFORT TO MINIMIZE THE IMPACT OF CONSTRUCTION ACTIVITY ON THE CONTINUING OPERATION OF THE CAMPUS AND BUILDINGS, AS NECESSARY.

L. THE CONTRACTOR SHALL PROVIDE APPROPRIATE BARRIERS BETWEEN THE CONSTRUCTION AREA AND THE REMAINDER OF THE SITE OR BUILDING, AND SHALL COMPLY WITH CALIFORNIA BUILDING CODE (CBC) SECTION 3303 - PROTECTION OF PEDESTRIANS DURING CONSTRUCTION OR DEMOLITION. IN ADDITION, THE CONTRACTOR SHALL PROVIDE ANY OTHER CONSTRUCTION FENCING, BARRICADES, WARNING SIGNS AND LIGHTS, AND SHALL EXERCISE ALL SAFETY MEASURES NECESSARY TO PROTECT AND RENDER THE PREMISES SAFE TO ALL PERSONS.

M. WHERE DEMOLITION OR OTHER DUST PRODUCING WORK IS PERFORMED ON BUILDING INTERIORS, PLASTIC DUST BARRIERS MUST BE ERECTED TO PREVENT DUST FROM SPREADING TO ADJACENT AREAS.

N. THE SCOPE OF WORK INCLUDES CLEANUP NECESSARY TO LEAVE THE BUILDING AND CONSTRUCTION AREA IN A NEAT AND USABLE CONDITION.

O. WHERE WORK REQUIRES THE PENETRATION OF EXTERIOR WALLS OR ROOFS, SUCH WORK SHALL BE FLASHED, SEALED OR OTHERWISE MADE TIGHT AGAINST THE ENTRANCE OF AIR OR WATER. SEE ARCHITECTURAL DRAWINGS FOR DETAILS.

2. TEST AND INSPECTIONS

A. PROVIDE TESTS AND INSPECTIONS FOR ALL ITEMS AS REQUIRED BY THE 2010 CALIFORNIA BUILDING CODE, WITH STATE OF CALIFORNIA AMENDMENTS CODE OF REGULATIONS.

B. THE OWNER SHALL BE RESPONSIBLE FOR RETAINING AN INDEPENDENT TESTING LAB TO PERFORM ALL REQUIRED TESTING AND INSPECTIONS.

C. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING THE TESTING LAB WITH CONSTRUCTION SCHEDULES TO ENSURE PROPER COORDINATION OF WORK.

D. SEE THE STRUCTURAL TESTS AND INSPECTION FORM FOR ITEMS REQUIRING TESTING. SPECIAL INSPECTION SHALL BE PROVIDED FOR REINFORCING STEEL AND WEDGE ANCHORS.

E. THE CONTRACTOR SHALL NOTIFY THE ENGINEER AND INSPECTOR A MINIMUM OF 48 HOURS PRIOR TO TIME OF INSPECTION.

3. DESIGN BASIS

A. APPLICABLE CODE: CALIFORNIA CODE OF REGULATIONS, 2010 EDITION (CCR), ALSO REFERRED TO AS THE CALIFORNIA BUILDING CODES (CBC)

B. ALL NEW CONSTRUCTION SHALL COMPLY WITH THE REQUIREMENTS OF THE 2010 EDITION CALIFORNIA BUILDING CODE.

C. VERTICAL LIVE LOADS:

1. ROOF: 20 PSF

D. LATERAL LOADS:

1. SEISMIC: SITE CLASS D

S_s = 1.0 R_p = 1.5
F_a = 1.0 a_p = 1.0
F_v = 1.5 z/h= 1.0
S_{ms} = 1.0
S_1 = 0.539
F_p = 0.8 W_p

2. WIND: EXPOSURE B, BASIC WIND SPEED = 85 MPH, I = 1.0

4. CAST-IN-PLACE CONCRETE

A. REINFORCE ALL CONCRETE. INSTALL ALL INSERTS, BOLTS, ANCHORS AND REINFORCING AND SECURELY TIE PRIOR TO PLACING CONCRETE.

B. CONCRETE SHALL BE HARDROCK CONCRETE AND SHALL ATTAIN THE FOLLOWING ULTIMATE COMPRESSIVE STRENGTHS AT 28 DAYS: EQUIPMENT PAD 3000 PSI.

C. CONSOLIDATE CONCRETE BY THE USE OF MECHANICAL VIBRATORS BUT DO NOT OVER VIBRATE.

D. ALL EXPOSED CORNERS OR EDGES OF PADS SHALL BE FORMED WITH A 3/4" CHAMFER UNLESS NOTED OTHERWISE.

E. CONCRETE IS TO COMPLY WITH CBC 1905.3 TO ESTABLISH CONCRETE PROPORTION.

a. REFERENCES -- COMPLY WITH THE FOLLOWING APPLICABLE STANDARDS UNLESS OTHERWISE SPECIFIED HEREIN:

1. CBC -- CALIFORNIA CODE OF REGULATIONS. TITLE 24, 2010 EDITION.
2. ASTM -- AMERICAN SOCIETY FOR TESTING AND MATERIALS.
3. ACI -- AMERICAN CONCRETE INSTITUTE'S.
   a. "SPECIFICATION FOR STRUCTURAL CONCRETE FOR BUILDINGS" (ACI 301).
   b. "RECOMMENDED PRACTICE FOR COLD WEATHER CONCRETING" (ACI 306).
   c. "RECOMMENDED PRACTICE FOR HOT WEATHER CONCRETING" (ACI 308).
   d. "RECOMMENDED PRACTICE FOR MEASURING, MIXING AND PLACING CONCRETE" (ACI 304).
   e. "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE" (ACI 318).
4. CCR -- STATE OF CALIFORNIA, BUSINESS AND TRANSPORTATION AGENCY. DIVISION OF HIGHWAYS "MATERIALS MANUAL".
5. CALIFORNIA DEPARTMENT OF GENERAL SERVICES, DIVISION OF THE STATE ARCHITECT. INTERPRETATION OF REGULATIONS DOCUMENT #19-3.

G. QUALITY ASSURANCE

A. THE CONTRACTOR'S TESTING LABORATORY QUALIFICATIONS: THE CONTRACTOR'S TESTING LABORATORY SHALL BE UNDER DIRECTION OF A CIVIL ENGINEER REGISTERED IN THE STATE OF CALIFORNIA, SHALL HAVE OPERATED SUCCESSFULLY FOR FOUR YEARS PRIOR TO THIS WORK, AND SHALL CONFORM TO REQUIREMENTS OF ASTM E329.

B. REQUIREMENTS OF ACI 301 SHALL GOVERN WORK, MATERIALS AND EQUIPMENT RELATED TO THIS SECTION; SPECIFICATIONS HEREIN SET MINIMUM RESULTS REQUIRED, AND REFERENCES TO PROCEDURES ARE INTENDED TO ESTABLISH MINIMUM GUIDES.

C. THE CONTRACTOR SHALL BE RESPONSIBLE FOR QUALITY OF CONCRETE IN PLACE AND SHALL BEAR BURDEN OF PROOF THAT CONCRETE MEETS MINIMUM REQUIREMENTS.

H. SUBMITTALS

1. THE CONTRACTOR'S TESTING LABORATORY'S CERTIFICATE OF COMPLIANCE.
2. THE CONTRACTOR SHALL SUBMIT:
   a. CERTIFIED COPIES OF MIX DESIGNS FOR EACH CONCRETE CLASS SPECIFIED INCLUDING COMPRESSIVE STRENGTH TEST REPORTS.
   b. CERTIFICATION THAT MATERIALS MEET REQUIREMENTS SPECIFIED.
   c. CERTIFICATION FROM VENDOR THAT SAMPLES ORIGINATE FROM AND ARE REPRESENTATIVE OF EACH LOT PROPOSED FOR USE.
3. THE OWNER'S TESTING AGENCY WILL SUBMIT REPORTS ON TESTS AND INSPECTIONS PERFORMED TO THE OWNER, THE ENGINEER, AND THE CONTRACTOR.

I. PRODUCT DELIVERY, STORAGE AND HANDLING

1. ENSURE STORAGE FACILITIES ARE WEATHER TIGHT AND DRY.
2. DELIVER AND STORE PACKAGED MATERIALS IN ORIGINAL CONTAINERS WITH SEALS UNBROKEN AND LABELS INTACT UNTIL TIME OF USE.
3. STORE BULK CEMENT IN BINS CAPABLE OF PREVENTING EXPOSURE TO MOISTURE.

J. PRODUCTS

CONCRETE CLASSES

CLASS	STRENGTH (PSI)	AGGREGATE (INCHES)	WEIGHT (PCF)	SLUMP (INCHES)	MIN. CEMENT PERCOURIC YD. (SACK)	W/C (BY WEIGHT)
A. EQUIPMENT PAD	3000	1	145	4	5.5	0.4

1. STRENGTH: COMPRESSIVE STRENGTH IN PSI AFTER 28-DAYS WHEN TESTED IN ACCORDANCE WITH ASTM C39. ALL CONCRETE SHALL DEVELOP COMPRESSION STRENGTH SPECIFIED IN 28-DAYS. TO MEET ABOVE REQUIREMENTS, MIX SHALL BE DESIGNED SUCH THAT AVERAGE COMPRESSIVE STRENGTH WILL EXCEED SPECIFIED 28-DAY STRENGTH BY AN AMOUNT AS SPECIFIED BY ACI 318.

K. MATERIALS

1. GENERAL REQUIREMENTS:
   a. CEMENT AND AGGREGATES SHALL HAVE PROVEN HISTORY OF SUCCESSFUL USE WITH ONE ANOTHER. SOURCES OF CEMENT AND AGGREGATE SHALL REMAIN UNCHANGED THROUGH-OUT WORK UNLESS THE
   b. READY-MIXED CONCRETE SHALL MEET REQUIREMENTS OF ASTM C94.
   c. DEVIATIONS IN PROPERTIES OF MATERIALS TESTED BY THE OWNER'S TESTING AGENCY SHALL BE CAUSE FOR THEIR REJECTION PENDING ADDITIONAL TEST RESULTS AND REDESIGN OF MIX BY THE CONTRACTOR'S TESTING LABORATORY.
   d. NO FROZEN AGGREGATES WILL BE PERMITTED.
2. CEMENTS:
   a. CONCRETE: ASTM C150, TYPE II. USE ONE BRAND OF CEMENT THROUGHOUT PROJECT.
3. FLY ASH: ASTM C618-05, CLASS N OR F (CLASS C IS NOT PERMITTED). UP TO 25% PERCENT OF FLY ASH BY WEIGHT IS PERMITTED TO BE SUBSTITUTED FOR ASTM C150 PORTLAND CEMENT IF THE MIX DESIGN IS PROPORTIONED PER CBC SECTION 1905.A.3 AND IN ACCORDANCE WITH ACI SECTION 5.3. PER ASTM C618, SAMPLING AND TESTING OF FLY ASH SHALL BE IN ACCORDANCE WITH ASTM C311.
   a. FLY ASH GENERATED FROM MUNICIPAL SOLID WASTE INCINERATORS OR COAL PLANTS FIRED WITH HAZARDOUS WASTE, MEDICAL WASTE OR TIRE-DERIVED FUEL IS PROHIBITED.
4. AGGREGATES:
   a. COARSE: ASTM C33. COARSE AGGREGATE SHALL CONSIST OF A CLEAN, HARD, FINE GRAINED, SOUND CRUSHED ROCK, OR WASHED GRAVEL OR A COMBINATION OF BOTH. IT SHALL BE FREE FROM OIL, ORGANIC MATTER OR OTHER DELETERIOUS SUBSTANCES AND SHALL NOT CONTAIN MORE THAN TWO PERCENT BY WEIGHT OF SHALE OR CHERTY MATERIAL. "CLEANNESS VALUE SHALL NOT BE LESS THAN 75 WHEN TESTED PER IAM TEST METHOD, 227 AND CONFORMING TO CBC SECTION 1903.1.
   b. FINES: ASTM C33. SAND EQUIVALENT SHALL BE NOT LESS THAN 75 WHEN TESTED AS PER ASTM D2419.
   c. PROVIDE AGGREGATES FROM A SINGLE SOURCE FOR EXPOSED CONCRETE.
5. WATER: CLEAN AND POTABLE, FREE FROM IMPURITIES DETRIMENTAL TO CONCRETE.
6. WATER-REDUCING ADMIXTURE: ASTM C494, TYPE A, NON-LIGNIN SULFONATE. SAME AS GRACE CONSTRUCTION MATERIALS' "WRDA WITH HYCOL". MASTER BUILDERS "POZZOLITH 322N"; SIKA CORP.'S "PLASTOCRETE 161", OR EQUAL.
   a. AIR ENTRAINING ADMIXTURE: ASTM C260, CERTIFIED BY MANUFACTURER TO BE COMPATIBLE WITH OTHER PRODUCTS. SAME AS W.R. GRACE'S "DARAVAIR", MASTER BUILDERS' "MICRO-AIR", SIKA CORP.'S "SIKA AEM", OR EQUAL.
   b. HIGH-RANGE WATER-REDUCING ADMIXTURE (SUPER PLASTICIZER): ASTM C494, TYPE F OR TYPE G. SAME AS W.R. GRACE'S "WRDA 19", MASTER BUILDERS' "RHEOBUILD", SIKA CORP.'S "SIKAMENT", OR EQUAL.
   c. WATER REDUCING, ACCELERATOR ADMIXTURE: ASTM C494, TYPE E. SAME AS W.R. GRACE'S "DARAGET", MASTER BUILDER'S "POZZUTEC 20", EUCLID'S "ACCELGUARD 80", OR EQUAL.
   d. WATER REDUCING, RETARDING ADMIXTURE: ASTM C494, TYPE D. SAME AS W.R GRACE'S "DARATARD-17", MASTER BUILDERS' "POZZOLITH R", SIKA'S "PLASTIMENT", OR EQUAL.

L. MIXES

1. GENERAL REQUIREMENTS:
   a. THE CONTRACTOR SHALL PERFORM TESTS OR ASSEMBLE THE NECESSARY DATA INDICATING CONFORMANCE WITH CONTRACT DOCUMENTS.
   b. FOR EACH MIX SUBMIT DATA SHOWING THAT PROPOSED MIX WILL ATTAIN THE REQUIRED STRENGTH IN ACCORDANCE WITH REQUIREMENTS OF CBC SECTION 1905.3.
   c. THE CONTRACTOR SHALL INSTRUCT LABORATORY TO BASE MIX DESIGN ON USE OF MATERIALS TESTED AND APPROVED BY THE OWNER'S TESTING AGENCY.
   d. MIX DESIGN SHALL INCLUDE COMPRESSION STRENGTH TEST REPORTS PER CBC SECTION 1905.
   e. IF MIX YIELD EXCEEDS 1-CUBIC YARD, MODIFY MIX DESIGN TO NO MORE THAN ONE CUBIC YARD WITHOUT CHANGING CEMENT CONTENT.
   f. INTRODUCTION OF CALCIUM CHLORIDE WILL NOT BE PERMITTED.
   g. UNSPECIFIED ADMIXTURES WILL NOT BE PERMITTED UNLESS THE ENGINEER REVIEWS, THE CONTRACTOR MODIFIES MIX DESIGNS AS NECESSARY, AND MODIFICATIONS ARE ACCEPTED BY THE OWNER'S TESTING AGENCY.
2. PATCHING MORTAR: MIX IN PROPORTIONS BY VOLUME OF ONE PART CEMENT TO TWO PARTS FINE SAND.

M. MIXING

1. BATCHING PLANT CONDITIONS:
   a. ENSURE EQUIPMENT AND PLANT WILL AFFORD ACCURATE WEIGHING, MINIMIZE SEGREGATION AND WILL EFFICIENTLY HANDLE ALL MATERIALS TO SATISFACTION OF THE ARCHITECT AND THE OWNER'S TESTING AGENCY.
   b. REPLACE AT NO ADDITIONAL EXPENSE EQUIPMENT THE ARCHITECT AND THE OWNER'S TESTING AGENCY DEEM INADEQUATE OR UNSUITABLE.
   c. USE APPROVED MOISTURE METER CAPABLE OF DETERMINING MOISTURE CONTENT OF SAND.
2. GENERAL REQUIREMENTS:
   a. THOROUGHLY CLEAN CONCRETE EQUIPMENT BEFORE USE FOR ARCHITECTURAL CONCRETE MIXES TO AVOID CONTAMINATION.
   b. MIX CEMENT, FINE AND COARSE AGGREGATES, ADMIXTURES AND WATER TO EXACT PROPORTIONS OF MIX DESIGNS. METHOD OF MIXING SHALL COMPLY WITH CBC SECTION 1905A.8.
   c. MEASURE FINE AND COARSE AGGREGATES SEPARATELY ACCORDING TO APPROVED METHOD WHICH PROVIDES ACCURATE CONTROL AND EASY CHECKING.
   d. ADJUST GRADING TO IMPROVE WORKABILITY; DO NOT ADD WATER UNLESS OTHERWISE DIRECTED.
   e. MAINTAIN PROPORTIONS, VALUES, OR FACTORS OF APPROVED MIXES THROUGHOUT WORK.
   f. MIX CONCRETE IN TRANSIT MIXERS FIVE MINUTES IMMEDIATELY PRIOR TO DISCHARGE IN ADDITION TO MIXING AS CALLED FOR BY ACI 304 AND ASTM C94.
3. ADMIXTURES: USE AUTOMATIC METERING DISPENSER TO INTRODUCE ADMIXTURE INTO MIX. DISPENSER SHALL BE RECOMMENDED AND CALIBRATED BY ADMIXTURE MANUFACTURER.

N. SOURCE QUALITY CONTROL

1. THE OWNER'S TESTING AGENCY WILL:
   a. REVIEW MIX DESIGNS, CERTIFICATES OF COMPLIANCE, AND SAMPLES OF MATERIALS THE CONTRACTOR PROPOSES TO USE.
   b. TEST AND INSPECT MATERIALS, AS NECESSARY, IN ACCORDANCE WITH ACI 318 AND CBC SECTIONS 1903 AND 1905 FOR COMPLIANCE WITH REQUIREMENTS.
   c. TAKE SAMPLES AS REQUIRED FROM THE CONTRACTOR'S DESIGNATED SOURCES.
   d. TEST BOTH COARSE AND FINE AGGREGATE BY USE OF SOLUTION OF SODIUM OR MAGNESIUM SULFATE, OR BOTH WHICHEVER IN THE JUDGMENT OF THE ARCHITECT SUCH TESTS ARE NECESSARY TO DETERMINE QUALITY OF MATERIAL. PERFORM SUCH TESTS IN ACCORDANCE WITH ASTM C88. LOSS SHALL NOT EXCEED 6-PERCENT OF EITHER FINE OR COARSE AGGREGATE. AGGREGATE FAILING TO COMPLY WITH THIS REQUIREMENT MAY BE USED IN THE WORK PROVIDED IT CONTAINS LESS THAN 2- PERCENT OF SHALE AND OTHER DELETERIOUS PARTICLES AND SHOWS A LOSS IN SOUNDNESS TEST OF NOT MORE THAN 10-PERCENT WHEN TESTED IN THE SODIUM SULPHATE SOLUTION. TEST AGGREGATES AS REQUIRED BY CBC SECTION 1903.
   e. TEST FOR SAND EQUIVALENT OF FINE AGGREGATE IN ACCORDANCE WITH CALIFORNIA TEST 217.
   f. TEST FOR CLEANNESS VALUE OF COARSE AGGREGATE IN ACCORDANCE WITH CALIFORNIA TEST 227.
   g. INSPECT PLANT PRIOR TO ANY WORK TO VERIFY FOLLOWING:
      i. PLANT IS EQUIPPED WITH APPROVED METERING DEVICES FOR DETERMINING MOISTURE CONTENT OF FINE AGGREGATE.
      ii. OTHER PLANT QUALITY CONTROLS ARE ADEQUATE.
   h. CONTINUOUSLY INSPECT QUALITY AND QUANTITY OF MATERIALS USED IN TRANSIT MIXED CONCRETE. IN BATCHED AGGREGATES AND READY-MIXED CONCRETE AT MIXING PLANT OR OTHER LOCATION PER CBC SECTION 1920A.4 WHERE OTHER MATERIALS ARE MEASURED.
   i. FLY ASH: CONTRACTOR SHALL SUPPLY THE OWNER'S TESTING LAB ADEQUATE SAMPLES FOR TESTING, IF REQUIRED AND CERTIFIED MILL ANALYSIS AND TEST REPORTS FOR OWNER'S TESTING LAB REVIEW.
   j. COMPLY WITH #619-3.
   k. SUBMIT CERTIFICATION BY MANUFACTURER THAT FLY ASH HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH ASTM C618 AND CCR, SECTION 1903. WHERE CERTIFICATION IS NOT AVAILABLE, ONE GRAB SAMPLE SHALL BE TAKEN AND TESTED FOR EACH DAY'S POUR IN ACCORDANCE WITH CCR SECTION 1905. SAMPLING AND TESTING SHALL BE IN ACCORDANCE WITH REQUIREMENTS OF ASTM C311.
   l. COMPLY WITH CCR SECTION 1903.
   m. IF ORIGIN OF FLY ASH IS UNKNOWN, THE FLY ASH SHALL BE SUBJECT TO WASTE EXTRACTION TEST PER CALIFORNIA HAZARDOUS WASTE CODE TITLE 22, CHAPTER 11, APPENDIX II. MERCURY CONCENTRATIONS MUST BE LESS THAN 11 PART PER BILLION.
2. WAIVER OF BATCH PLANT INSPECTION:
   a. CONTINUOUS BATCH PLANT INSPECTION MAY BE WAIVED IN ACCORDANCE WITH CBC SECTION 1920A.5 IF THE PLANT COMPLIES WITH ASTM C94 AND HAS BEEN CERTIFIED BY AN AGENCY ACCEPTABLE TO DSA TO COMPLY WITH THE REQUIREMENTS OF THE NATIONAL READY MIX CONCRETE ASSOCIATION.
   b. WHEN BATCH PLANT INSPECTION IS WAIVED, THE FOLLOWING REQUIREMENTS SHALL APPLY:
      i. TESTING AGENCY SHALL CHECK THE FIRST BATCHING AT THE START OF WORK AND FURNISH MIX PROPORTIONS TO THE LICENSED WEIGHMASTER.
      ii. LICENSED WEIGHMASTER SHALL IDENTIFY MATERIAL QUANTITIES AND CERTIFY EACH LOAD BY A TICKET.
      iii. PROJECT INSPECTOR SHALL COLLECT TRUCK MIX TICKETS WITH LOAD IDENTIFICATION AND MAINTAIN A DAILY RECORD OF PLACEMENT. TRUCKS WITHOUT A LOAD TICKET IDENTIFYING THE MIX SHALL BE REJECTED. COPIES OF DAILY PLACEMENT RECORD SHALL BE SUBMITTED TO DSA.
      iv. AT THE END OF THE PROJECT, THE WEIGHMASTER SHALL SUBMIT AN AFFIDAVIT TO DSA CERTIFYING THAT ALL CONCRETE SUPPLIED CONFORMS TO PROPORTIONS ESTABLISHED BY MIX DESIGNS.

O. EXECUTION

1. EXAMINATION
   a. EXAMINE UNITS OF WORK TO BE CAST AND VERIFY THAT:
      i. CONSTRUCTION OF FORMWORK IS COMPLETE.
      ii. REQUIRED REINFORCEMENT, INSERTS, AND EMBEDDED ITEMS ARE IN PLACE.
      iii. CONCRETE-RECEIVING PLACES ARE FREE OF DEBRIS.
      iv. CONVEYING EQUIPMENT IS CLEAN AND PROPERLY OPERATING.
      v. THE INSPECTOR OF RECORD HAS REVIEWED FORMWORK AND REINFORCING STEEL.
   b. DO NOT BEGIN CASTING BEFORE UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED.
   c. AT LOCATIONS WHERE NEW CONCRETE IS DOWELED TO EXISTING WORK, DRILL HOLES IN EXISTING CONCRETE, INSERT STEEL DOWELS, AND PACK SOLID WITH NON-SHRINK GROUT.
2. PREPARATION
   a. ENSURE AVAILABILITY OF SUFFICIENT LABOR, EQUIPMENT AND MATERIALS TO PLACE CONCRETE CORRECTLY IN ACCORDANCE WITH SCHEDULED CASTING.
   b. PROTECT FINISHED SURFACES ADJACENT TO CONCRETE-RECEIVING PLACES.
   c. CLEAN TRANSPORTATION AND HANDLING EQUIPMENT AT FREQUENT INTERVALS AND FLUSH THOROUGHLY WITH WATER BEFORE EACH DAY'S RUN. DO NOT DISCHARGE WASH WATER INTO CONCRETE FORM.
3. PLACING
   a. THE INSPECTOR OF RECORD, STRUCTURAL ENGINEER, TESTING LABORATORY AND DSA SHALL BE NOTIFIED AT LEAST 48 HOURS BEFORE PLACING CONCRETE.
   b. PLACE CONCRETE IN ACCORDANCE WITH CBC SECTION 1905A.
   c. PLACE CONCRETE IN A CONTINUOUS OPERATION TO PERMIT PROPER AND THOROUGH INTEGRATION AND TO COMPLETE SCHEDULED PLACEMENT. PLACE NO CONCRETE WHERE SUN, WIND, HEAT, OR FACILITIES PREVENT PROPER FINISHING AND CURING.
   d. CONVEY CONCRETE AS RAPIDLY AND DIRECTLY AS PRACTICABLE TO PRESERVE QUALITY AND TO PREVENT SEPARATION FROM REHANDLING AND FLOWING; DO NOT DEPOSIT CONCRETE INITIALLY SET. CAST CONCRETE WITHIN NINETY (90) MINUTES AFTER ADDING WATER UNLESS OTHERWISE NOTED. RETEMPERING OF CONCRETE WHICH HAS PARTIALLY SET WILL NOT BE PERMITTED.
   e. TAKE PRECAUTIONS TO AVOID DAMAGE TO DISPLACEMENT OF REINFORCEMENT AND FORMWORK.
   f. KEEP FORMS AND REINFORCEMENT CLEAN ABOVE POUR LINE BY REMOVING CLINGING CONCRETE WITH WIRE BRUSH BEFORE CASTING NEXT LIFT. ALSO REMOVE LEAKAGE THROUGH FORMS.
   g. INTERRUPTION IN CASTING LONGER THAN 60-MINUTES SHALL BE CAUSE FOR DISCONTINUING CASTING FOR REMAINDER OF DAY. IN THIS EVENT, CUT BACK CONCRETE AND PROVIDE CONSTRUCTION JOINTS AS THE ARCHITECT DIRECTS; CLEAN FORMS AND REINFORCEMENT AS NECESSARY TO RECEIVE CONCRETE AT A LATER TIME.
   h. CONSOLIDATING:
      i. USE VIBRATORS FOR THOROUGH CONSOLIDATION OF CONCRETE.
      ii. PROVIDE VIBRATORS FOR EACH LOCATION DURING SIMULTANEOUS PLACING TO ENSURE TIMELY CONSOLIDATION AROUND REINFORCEMENT, EMBEDDED ITEMS AND INTO CORNERS OF FORMS; ENSURE AVAILABILITY OF SPARE VIBRATORS IN CASE OF FAILURES. VIBRATE THROUGH FULL DEPTH OF FRESHLY PLACED CONCRETE.
      iii. DO NOT PLACE VIBRATORS AGAINST REINFORCEMENT, ATTACH TO FORMS, OR USE TO SPREAD CONCRETE.
      iv. EXPOSED CONCRETE: VIBRATE WITH RUBBER TYPE HEADS AND, IN ADDITION, SPADE ALONG FORMS WITH FLAT STRAP OR PLATE.
4. CURING
   a. GENERAL REQUIREMENTS:
      i. TAKE CURING MEASURES IMMEDIATELY AFTER CASTING AND FOR MEASURES OTHER THAN APPLICATION OF CURING COMPOUNDS, EXTEND FOR SEVEN DAYS. THE ARCHITECT MAY RECOMMEND LONGER PERIODS BASED UPON PREVAILING TEMPERATURE, WIND AND RELATIVE HUMIDITY. COMPLY WITH CBC SECTION 1905A.11.
      ii. AVOID ALTERNATE WETTING AND DRYING AND FLUCTUATIONS OF CONCRETE TEMPERATURE.
      iii. PROTECT FRESH CONCRETE FROM DIRECT RAYS OF SUN, RAIN, FREEZING, DRYING WINDS, SOILING, AND DAMAGE.
      iv. DO NOT PERMIT CURING METHOD TO AFFECT ADVERSELY FINISHES OR TREATMENTS APPLIED TO FINISH CONCRETE.

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TRS

JOB TITLE

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

AS NOTED

50% REVIEW	2/13/13	A

SHEET INFORMATION

date	2/14/2013
job	SFPU - 13006
scale	AS NOTED
drawn	FMC
checked by	MT/WM

STRUCTURAL GENERAL NOTES, AND SPECIFICATIONS

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4. CAST-IN-PLACE CONCRETE (CONTINUED)

b. CURING METHOD, TYPICAL: OBTAIN THE ENGINEER'S APPROVAL OF ALTERNATE MEASURES.

i. KEEP FORMS AND CONCRETE SURFACES MOIST DURING PERIOD FORMS ARE REQUIRED TO REMAIN IN PLACE.

ii. APPLY CURING COMPOUND PER MANUFACTURERS' RECOMMENDATIONS. APPLY CURING COMPOUND AT 150% OF MANUFACTURER'S RECOMMENDED APPLICATION COVERAGE RATE.

5. CLEANING, PATCHING AND DEFECTIVE WORK

a. WHERE CONCRETE IS UNDER STRENGTH, OUT OF LINE, LEVEL OR PLUMB, OR SHOWS OBJECTIONABLE CRACKS, HONEYCOMBING, ROCK POCKETS, VOIDS, SPALLING, EXPOSED REINFORCEMENT, SIGNS OF FREEZING OR IS OTHERWISE DEFECTIVE, AND, IN THE ENGINEER'S JUDGEMENT, THESE DEFECTS IMPAIR PROPER STRENGTH OR APPEARANCE OF THE WORK, THE ENGINEER WILL REQUIRE ITS REMOVAL AND REPLACEMENT AT THE CONTRACTOR'S EXPENSE.

b. IMMEDIATELY AFTER STRIPPING AND BEFORE CONCRETE IS THOROUGHLY DRY, PATCH MINOR DEFECTS, FORM-TIE HOLES, HONEYCOMBED AREAS, ETC., WITH PATCHING MORTAR. PATCH SHALL MATCH FINISH OF ADJACENT SURFACE UNLESS OTHERWISE NOTED. REMOVE LEDGES AND BLACES.

c. COMPACT MORTAR INTO PLACE AND NEATLY FILE DEFECTIVE SURFACES TO PRODUCE LEVEL, TRUE PLANES. AFTER INITIAL SET, DRESS SURFACES OF PATCHES MECHANICALLY OR MANUALLY TO OBTAIN SAME TEXTURE AS SURROUNDING SURFACES.

d. ROCK POCKETS:

1. CUT OUT TO FULL SOLID SURFACE AND FORM KEY.

2. THOROUGHLY WET BEFORE CASTING MORTAR.

3. WHERE THE ENGINEER DEEMS ROCK POCKET TOO LARGE FOR SATISFACTORY MORTAR PATCHING AS DESCRIBED, CUT OUT DEFECTIVE SECTION TO SOLID SURFACE, KEY AND PACK SOLID WITH CONCRETE TO PRODUCE FIRM BOND AND MATCH ADJACENT SURFACE.

e. CLEANING

i. INSURE REMOVAL OF BITUMINOUS MATERIALS, FORM RELEASE AGENTS, BOND BREAKERS, CURING COMPOUNDS IF PERMITTED AND OTHER MATERIALS EMPLOYED IN WORK OF CONCRETING WHICH WOULD OTHERWISE PREVENT PROPER APPLICATION OF SEALANTS, LIQUID WATERPROOFING, AND OTHER DELAYED FINISHES AND TREATMENTS.

ii. WHERE CLEANING IS REQUIRED, TAKE CARE NOT TO DAMAGE SURROUNDING SURFACES OR LEAVE RESIDUE FROM CLEANING AGENTS.

6. PROTECTION

a. PROTECT CONCRETE FROM INJURIOUS ACTION OF THE ELEMENTS AND DEFACEMENT OF ANY NATURE DURING CONSTRUCTION OPERATIONS.

b. PROTECT EXPOSED CORNERS OF CONCRETE FROM TRAFFIC OR USE WHICH WILL DAMAGE THEM IN ANY WAY.

c. MAKE PROVISIONS TO KEEP ALL EXPOSED CONCRETE FREE FROM LATANCE CAUSED BY SPILLAGE OR LEAKING FORMS OR OTHER CONTAMINANTS. DO NOT ALLOW LATANCES TO PENETRATE, STAIN, OR HARDEN ON SURFACES WHICH HAVE BEEN TEXTURED.

7. FIELD QUALITY CONTROL

a. THE OWNER'S TESTING AGENCY WILL:

i. PERFORM TESTING IN ACCORDANCE WITH ACI 318 AND CBC SECTION 1903A AND 1905A.

ii. REVIEW CONCRETE MIX DESIGNS.

iii. INSPECT CONCRETE AND GROUT PLACEMENT CONTINUOUSLY.

iv. TEST CONCRETE TO CONTROL SLUMPS ACCORDING TO ASTM C143.

v. CONTINUOUSLY MONITOR CONCRETE TEMPERATURE AS IT ARRIVES ON THE SITE.

vi. TEST CONCRETE FOR REQUIRED COMPRESSIVE STRENGTH IN ACCORDANCE WITH CBC SECTION 1905A.II:

1. MAKE AND CURE THREE SPECIMEN CYLINDERS ACCORDING TO ASTM C31 FOR EACH 150 CUBIC YARDS, OR FRACTION THEREOF, OF EACH CLASS POURED AT SITE EACH DAY.

2. RETAIN ONE CYLINDER FOR 7-DAY TEST AND TWO FOR THE 28-DAY TEST.

3. NUMBER EACH CYLINDER 1A, 1B, 1C, 3A, 2B, 2C, ETC; DATE EACH SET, AND KEEP ACCURATE RECORD OF POUR EACH SET REPRESENTS.

4. TRANSPORT SPECIMEN CYLINDERS FROM JOB TO LABORATORY AFTER CYLINDERS HAVE CURED FOR 24-HOURS ON SITE. CYLINDERS SHALL BE COVERED AND KEPT AT AIR TEMPERATURES BETWEEN 60 AND 80 DEGREES FAHRENHEIT.

5. TEST SPECIMEN CYLINDERS AT AGE 7-DAYS AND AGE 28-DAYS FOR SPECIFIED STRENGTH ACCORDING TO ASTM C39.

6. BASE STRENGTH VALUE ON AVERAGE OF TWO CYLINDERS TAKEN FOR 28-DAY TEST.

vii. TEST AND INSPECT MATERIALS, AS NECESSARY, IN ACCORDANCE WITH ACI 318. MIN TEST METHOD 227 (COARSE AGGREGATES) AND MIN TEST METHOD 217 (FINE AGGREGATES), FOR COMPLIANCE WITH REQUIREMENTS SPECIFIED IN THIS SECTION.

b. THE CONTRACTOR SHALL:

i. SUBMIT TICKET FOR EACH BATCH OF CONCRETE DELIVERED TO JOB SITE. TICKET SHALL BEAR THE FOLLOWING INFORMATION:

1. DESIGN MIX NUMBER.

2. SIGNATURE OR INITIALS OF READY MIX REPRESENTATIVE.

3. TIME OF BATCHING.

4. WEIGHT OF CEMENT, AGGREGATES, WATER AND ADMIXTURES IN EACH BATCH WITH MAXIMUM AGGREGATE SIZE.

5. TOTAL VOLUME OF CONCRETE IN EACH BATCH.

6. NOTATION TO INDICATE EQUIPMENT WAS CHECKED FOR CONTAMINANTS PRIOR TO BATCHING.

ii. PAY THE OWNER'S TESTING AGENCY FOR TAKING CORE SPECIMENS OF HARDENED STRUCTURE AND TESTING SPECIMEN ACCORDING TO ASTM C39 AND C42 WHEN LABORATORY TESTS OF SPECIMEN CYLINDERS SHOW COMPRESSIVE STRENGTHS BELOW SPECIFIED MINIMUM.

8. FINISH OF FORMED SURFACES

a. ROUGH FORM FINISH: FOR FORMED CONCRETE SURFACES NOT EXPOSED-TO-VIEW IN THE FINISH WORK OR BY OTHER CONSTRUCTION. CONCRETE SURFACE SHALL HAVE TEXTURE IMPARTED BY FORM FACING MATERIAL USED, WITH TIE HOLES AND DEFECTIVE ANGLES REPAIRED AND PATCHED AND FINS AND OTHER PROJECTIONS EXCEEDING 1/4 INCH IN HEIGHT RUBBED DOWN OR CHIPPED OFF.

b. SMOOTH FORM FINISH: FOR FORMED CONCRETE SURFACES EXPOSED-TO-VIEW, OR TO BE COVERED WITH A COATING MATERIAL APPLIED DIRECTLY TO CONCRETE, OR A COVERING MATERIAL APPLIED DIRECTLY TO CONCRETE, SUCH AS WATERPROOFING, DAMPPROOFING, PAINTING OR OTHER SIMILAR SYSTEM. THIS IS AS-CAST CONCRETE SURFACE OBTAINED WITH SELECTED FORM FACING MATERIAL, ARRANGED ORDERLY AND SYMMETRICALLY WITH A MINIMUM OF SEAMS. REPAIR AND PATCH DEFECTIVE AREAS WITH FINS OR OTHER PROJECTIONS COMPLETELY REMOVED AND SMOOTHED.

P. CLEAN UP

1. PERFORM WORK UNDER THIS SECTION TO KEEP AFFECTED PORTIONS OF BUILDING SITE NEAT, CLEAN, AND ORDERLY. REMOVE, IMMEDIATELY UPON COMPLETION OF WORK UNDER THIS SECTION, SURPLUS MATERIALS, RUBBISH, AND EQUIPMENT ASSOCIATED WITH OR USED IN PERFORMANCE. BE AWARE THAT FAILURE TO PERFORM CLEAN-UP OPERATIONS WITHIN 24 HOURS OF NOTICE BY ARCHITECT WILL BE CONSIDERED ADEQUATE GROUNDS FOR HAVING WORK DONE BY OTHERS AT NO ADDED EXPENSE TO THE OWNER.

5. CONCRETE REINFORCEMENT

A. ALL REINFORCING STEEL BARS SHALL CONFORM WITH THE STANDARD SPECIFICATIONS FOR DEFORMED BILLET-STEEL FOR CONCRETE REINFORCEMENT, ASTM DESIGNATION A615, BARS #5 AND LARGER SHALL BE GRADE 60, ALL OTHER BARS SHALL BE MINIMUM GRADE 60 ALL BARS, UNLESS OTHERWISE NOTED. ALL WELDED REINF. SHALL BE ASTM A706.

B. SUITABLE DEVICES OF SOME STANDARD MANUFACTURE SHALL BE USED TO HOLD REINFORCEMENT IN ITS TRUE HORIZONTAL AND VERTICAL POSITIONS. THESE DEVICES SHALL BE SUFFICIENTLY RIGID AND NUMEROUS TO PREVENT DISPLACEMENT OF THE REINFORCING DURING PLACING OF CONCRETE.

C. REFERENCES

1. CCR - CALIFORNIA CODE OF REGULATIONS, CHAPTER 16 (ACI 318).

2. ACI 301 - SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS.

3. ACI 315 (SP-66) - DETAILS AND DETAILING OF CONCRETE REINFORCEMENT.

4. ACI 318 - BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.

5. ASTM A82 - COLD DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT.

6. ASTM A185 - WELDED STEEL WIRE FABRIC FOR CONCRETE REINFORCEMENT.

7. ASTM A615 - DEFORMED AND PLAIN BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT.

8. ASTM A706 - STANDARD SPECIFICATION FOR LOW ALLOY STEEL DEFORMED BARS FOR CONCRETE REINFORCEMENT.

9. ASTM C1116 - SPECIFICATION FOR FIBER-REINFORCED CONCRETE AND SHOTCRETE.

10. AWS D1.4 - STRUCTURAL WELDING CODE REINFORCING STEEL.

11. CRSI - MANUAL OF PRACTICE.

12. CRSI - PLACING REINFORCING BARS.

D. QUALITY ASSURANCE

1. PERFORM CONCRETE REINFORCEMENT WORK IN ACCORDANCE WITH CRSI MANUAL OF STANDARD PRACTICE.

2. CONFORM TO SPECIAL INSPECTION REQUIREMENTS OF CBC CHAPTER 17A.

E. CERTIFICATES

1. SUBMIT MILL TEST CERTIFICATES OF SUPPLIED CONCRETE REINFORCING, INDICATING PHYSICAL AND CHEMICAL ANALYSIS.

F. MATERIALS

1. REINFORCING STEEL: ASTM A615, GRADE 60, BILLET-STEEL DEFORMED BARS, UNCOATED FINISH.

2. WELDED REINFORCEMENT: ASTM A706, GRADE 60, DEFORMED BARS, UNFINISHED.

G. ACCESSORY MATERIALS

1. TIE WIRE: MINIMUM 16 GAGE ANNEALED TYPE.

2. CHAIRS, BOLSTERS, BAR SUPPORTS, SPACERS: SIZED AND SHAPED FOR STRENGTH AND SUPPORT OF REINFORCEMENT DURING INSTALLATION AND PLACEMENT OF CONCRETE INCLUDING LOAD BEARING PAD ON BOTTOM TO PREVENT VAPOR BARRIER PUNCTURE.

H. EXECUTION

1. INSTALLATION

a. BEFORE PLACING CONCRETE, CLEAN REINFORCEMENT OF FOREIGN PARTICLES OR COATINGS.

b. PLACE, SUPPORT, AND SECURE REINFORCEMENT AGAINST DISPLACEMENT. DO NOT DEVIATE FROM ALIGNMENT OR MEASUREMENT.

c. DOWEL INTO EXISTING CONCRETE AS DETAILED.

2. FIELD QUALITY CONTROL

a. INSPECTION AND TESTING WILL BE PERFORMED UNDER PROVISIONS OF FORM DSA-103 AS REQUIRED BY THE DIVISION OF STATE ARCHITECT.

6. PHOTOVOLTAIC SUPPORT FRAMING

A. SCOPE OF WORK

1. PROVIDE ALL SOLOUCH (BY SOLON) OR EQUAL FRAMING MATERIAL, FITTING AND RELATED ACCESSORIES (INCLUDING SOLON Z-CLIPS) AS INDICATED ON THE CONTRACT DRAWINGS.

2. PROVIDE ALL LABOR, SUPERVISION, ENGINEERING AND FABRICATION REQUIRED FOR INSTALLATION OF THE SOLON SYSTEM IN ACCORDANCE WITH THE CONTRACT DRAWINGS AND AS SPECIFIED HEREIN.

B. SUBMITTALS

1. SUBMIT ALL PERTINENT MANUFACTURERS PUBLISHED DATA.

2. ALL MATERIAL IS TO BE DELIVERED TO THE WORK SITE IN ORIGINAL FACTORY PACKAGING TO AVOID DAMAGE TO THE FINISH.

C. MATERIALS

1. SOLON Z-CLIP 6" ROOF PENETRATION ASSEMBLY SHALL BE C80 HOT DIPPED GALVANIZED PER ASTM A123 AND A385.

2. ECO FASTEN SOLAR ASSEMBLY (BY ECO FASTEN SOLAR) SHALL CONSIST OF F-6CSR (1¼" OC) ALUMINUM POST WITH ⅜" - 16 THREADED HOLE IN ONE END AND COUNTERSUNK IN OPPOSITE END AND WITH STAINLESS STEEL ECO-44 BASE PLATE.

3. FASTENERS SHALL BE STAINLESS STEEL (BY ONK FASTENERS OR EQUAL) AS INDICATED IN CONTRACT DOCUMENTS.

7. MISCELLANEOUS STEEL

A. STEEL MATERIALS SHALL CONFORM TO THE FOLLOWING:

PLATES	ASTM A304 S.S.

8. WEDGE ANCHORS

A. REFER TO MANUFACTURER SPECIFICATIONS FOR COMPLETE INFORMATION.

B. WEDGE ANCHORS SHALL BE HILTI "KWIK BOLT TZ" OR SIMPSON STRONG BOLT OR EQUAL. ALL ANCHORS SHALL BE STAINLESS STEEL.

C. EMBEDMENTS SHALL BE AS SHOWN ON THE DRAWINGS.

D. MINIMUM DESIGN SHEAR AND TENSION AS LISTED BELOW SHALL BE BOX OF THE ICC-ES REPORT VALUES FOR TWO THOUSAND POUND PER SQUARE INCH (2000 PSI) HARD ROCK CONCRETE.

ANCHOR DIAMETER (INCHES)	DEPTH OF EMBEDMENT (INCHES)	DESIGN VALUE (POUNDS) TENSION/SHEAR	TENSION TEST LOAD (POUNDS)	TORQUE TEST LOAD (FT. POUNDS)
3/8	2-3/8	1136.1252	2272	25
1/2	3-1/4	1326.3049	2650	40

E. TESTING

1. ALL INSTALLED WEDGE ANCHORS SHALL BE TESTED TO THE VALUES TABULATED ABOVE. DO NOT REMOVE NUT FOR TEST. THE CONTRACTOR SHALL PROVIDE SUFFICIENT THREAD LENGTH TO PERFORM TENSION TEST.

2. REACTION LOADS FROM TEST FIXTURE MUST NOT RESTRAIN ANCHOR FROM WITHDRAWING. TEST EQUIPMENT IS TO BE CALIBRATED BY AN APPROVED TESTING LABORATORY IN ACCORDANCE WITH STANDARD RECOGNIZED PROCEDURES.

3. TESTS SHOULD OCCUR 24 HOURS MINIMUM AFTER THE INSTALLATION OF THE SUBJECT ANCHOR.

4. ACCEPTANCE CRITERIA FOR INSTALLED ANCHORS: HYDRAULIC RAM METHOD: THE ANCHOR SHALL HAVE NO OBSERVABLE MOVEMENT AT THE APPLICABLE TEST LOAD. THE WASHER UNDER THE NUT MUST NOT BECOME LOOSE.

TORQUE WRENCH METHOD: THE APPLICABLE TEST TORQUE MUST BE REACHED WITHIN

9. DRILLED DOWELS

A. ALL DRILLED DOWELS SHALL BE REINFORCING STEEL AS DEFINED IN THE GENERAL NOTES AND AS NOTED ON THIS SHEET. DRILLED DOWELS IN CONCRETE SHALL BE SET IN HILTI RE-7PY-SD (ESR 2322) OR SIMPSON SET XP (ESR 2508) OR APPROVED EQUAL, UNLESS NOTED OTHERWISE ON THE DRAWINGS.

B. WHEN INSTALLING DRILLED DOWELS IN EXISTING REINFORCED CONCRETE, USE CARE AND CAUTION TO AVOID CUTTING OR DAMAGING THE EXISTING REINFORCING BARS. HOLES FOR DRILLED DOWELS SHALL NOT BE CORED.

C. HOLED DIAMETERS SHOWN SHALL BE USED UNLESS SPECIFICALLY RECOMMENDED BY MANUFACTURER OF RESIN MATERIAL. WHERE EXISTING REINFORCING STEEL IS ENCOUNTERED, SHIFT THE DOWEL AS REQUIRED TO AVOID IT. DRILLED DOWELS/ANCHORS SHALL HAVE MINIMUM EMBEDMENTS TABULATED BELOW UNLESS NOTED OTHERWISE ON THE DRAWINGS. THE TESTING LABORATORY SHALL LOAD TEST 10% OF EACH SIZE DOWEL TO THE LOAD SPECIFIED. IF ANY ONE DOWEL/ANCHOR INSTALLED IN ANY ONE DAY FAILS THIS TEST, ALL DOWELS/ANCHORS OF ALL SIZES INSTALLED THAT DAY SHALL BE TESTED.

MATERIALS	BAR SIZE ANCH DIAMETER	MAXIMUM HOLE DIAMETER	MINIMUM EMBEDMENT	PROOF LOAD (POUNDS)
CONC/	#3	¾"	5 ½"	3,500
REBAR	#4	⅞"	7"	8,400

ABBREVIATIONS

ø - DIAMETER	L.L. - LIVE LOAD
& - AND	L.H. - LONG LEG HORIZONTAL
@ - AT	L.V. - LONG LEG VERTICAL
℄ - CENTER LINE	
▭ - PLATE	M.B. - MACHINE BOLT
	MAX. - MAXIMUM
ABT. - ABOUT	MIN. - MINIMUM
A.B. - ANCHOR BOLT	
A.T.R. - ALL THREADED ROD	N.S. - NEAR SIDE
	(N) - NEW
BLDG. - BUILDING	N.I.C. - NOT IN CONTRACT
BLKG. - BLOCKING	N.T.S. - NOT TO SCALE
BM. - BEAM	
B.S. - BOTH SIDES	O.C. - ON CENTER
BOTT. - BOTTOM	OPNG - OPENING
BETW. - BETWEEN	O.N. - OPPOSITE HAND
	O.F. - OUTSIDE FACE
CL - CENTERLINE	
CLR. - CLEAR	PL - PLATE
CMU - CONCRETE MASONRY UNIT	PLYWD - PLYWOOD
COL - COLUMN	P.W. - PLYWOOD
C.P. - COMPLETE PENETRATION	P.T.W. - PRESSURE TREATED WOOD
CLG. - CEILING	
CONC. - CONCRETE	REINF. - REINFORCEMENT
CONN. - CONNECTION	R.C. - REINFORCED CONCRETE
C.J. - CONSTRUCTION JOINT	REQ'D. - REQUIRED
CONT. - CONTINUOUS	
	SECT. - SECTION
DET. - DETAIL	S.A.D. - SEE ARCHITECTURAL DRAWING
DIA. - DIAMETER	SHT. - SHEET
DS. - DIAGONAL SHEATHING	SIM. - SIMILAR
DWG. - DRAWING	S.B. - SOLID BLOCKING
	SPECS. - SPECIFICATIONS
(E) - EXISTING	SQ. - SQUARE
EA. - EACH	STAGD. - STAGGERED
E.F. - EACH FACE	STIFF. - STIFFENER
E.S. - EACH SIDE	STL. - STEEL
E.N. - EDGE NAIL	SYMM. - SYMMETRICAL
ELEV. - ELEVATION	
EMBED. - EMBEDMENT	T. - TOP
EQ. - EQUAL	T.O. - TIE DOWN
(E) - EXISTING	T.N. - TOE NAIL
	T.O.C. - TOP OF CONCRETE
F.S. - FAR SIDE	T.O.S. - TOP OF STEEL
FLG. - FLANGE	TYP. - TYPICAL
FLR. - FLOOR	
FTG. - FOOTING	U.O.N. - UNLESS OTHERWISE NOTED
FDN. - FOUNDATION	U.N.O. - UNLESS NOTED OTHERWISE
GA. - GAGE	V.I.F. - VERIFY IN FIELD
GALV. - GALVANIZED	VERT. - VERTICAL
G.B. - GRADE BEAM	
	W/ - WITH
HORIZ. - HORIZONTAL	W.P. - WORK POINT
HT. - HEIGHT	
	WP - WATERPROOFING
INFO. - INFORMATION	W.A. - WEDGE ANCHOR

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PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

DSA PERMIT	04/04/12	A

SHEET INFORMATION

Date	7/14/2013
Job	STPD 13.008
Scale	AS NOTED
Drawn	FMC
Checked By	MT/MB

STRUCTURAL SPECIFICATIONS AND ABBREVIATIONS

SHEET

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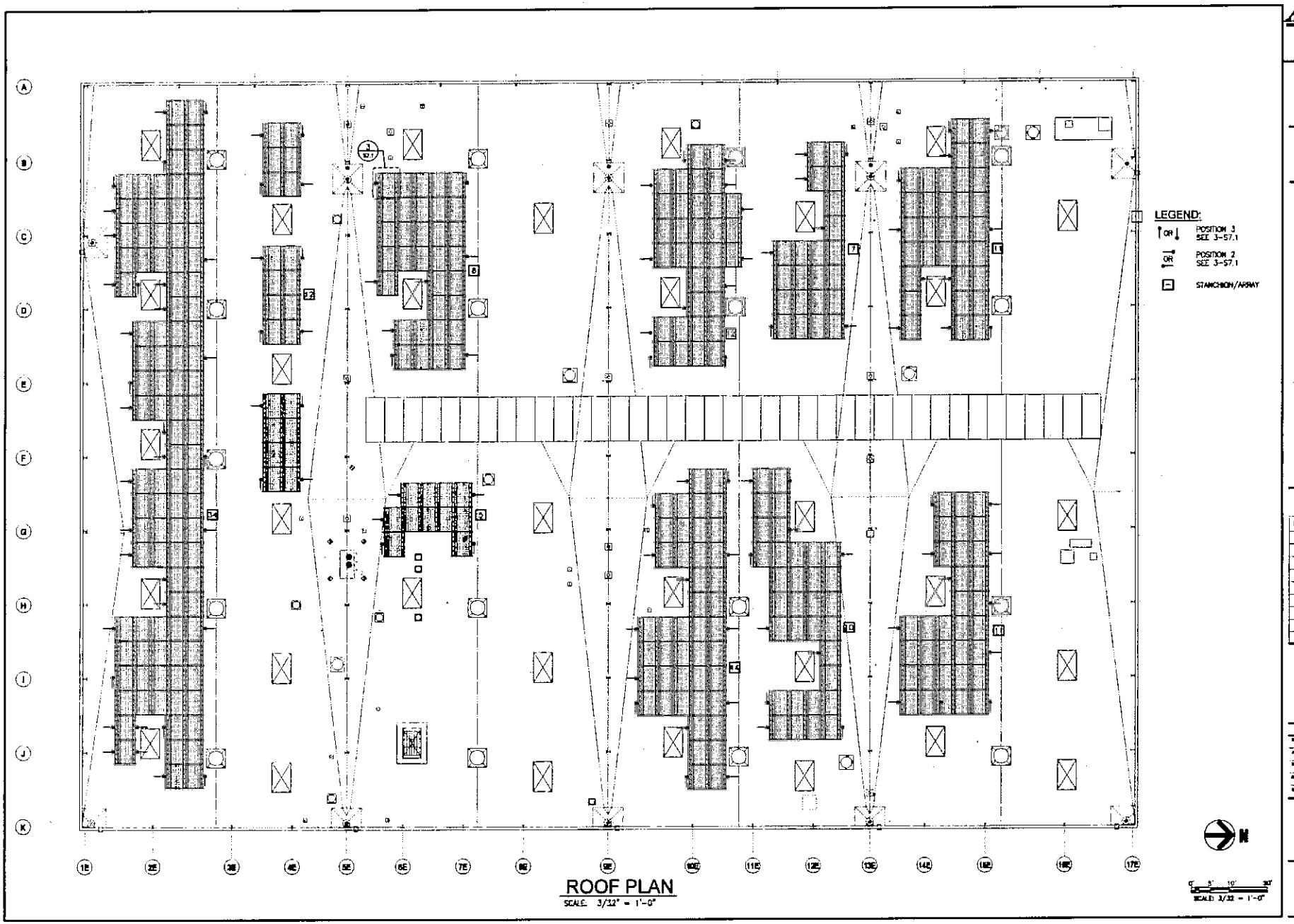
OF SHEETS



ROOF PLAN
SCALE: 3/32" = 1'-0"

SCALE: 3/32" = 1'-0"

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700 Pennsylvania Avenue, San Francisco, CA

BDS REVIEW	3/1/13	A

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SFPU-13008
N.T.S.
CHK
RK

STRUCTURAL ROOF PLAN

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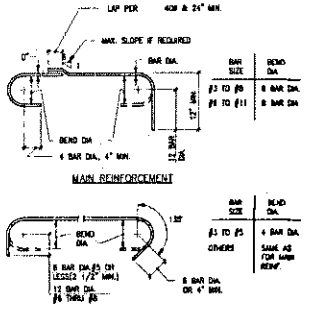


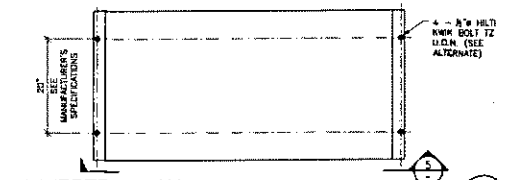
TYPICAL BAR HOOKS AND BENDS (5)

SCALE: NONE

MINIMUM CONCRETE COVER FOR REINFORCING STEEL (FROM SURFACE OF CONCRETE TO SURFACE OF STEEL)	
SURFACE CAST AGAINST EARTH (EXCEPT SLAB OR GRADE)	3"
SURFACE EXPOSED TO EARTH OR WEATHER	
NO. 6 AND LARGER BAR	2"
NO. 5 AND SMALLER BAR OR WWF	1 1/2"
SURFACE NOT EXPOSED TO EARTH OR WEATHER	
STRUCTURAL SLAB TO BOTTOM BARS	1"
STRUCTURAL SLAB TO TOP BARS	3/4"
WALL	1"
JOIST OR WAFFLE TO STIRRUPS	1"
BEAM TO STIRRUPS	1 1/2"
COLUMN TO SPIRAL OR TIES	1 1/2"
SHOTCRETE WALL AT FORMED FACE	2"

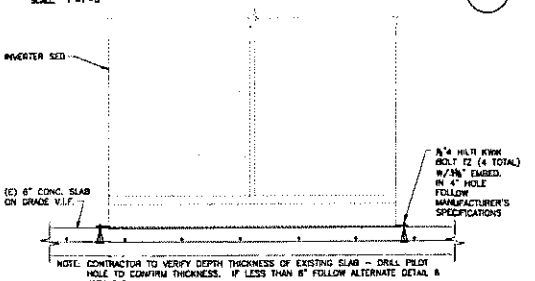
CONCRETE PROTECTION FOR REINF. STEEL (6)

SCALE: NONE



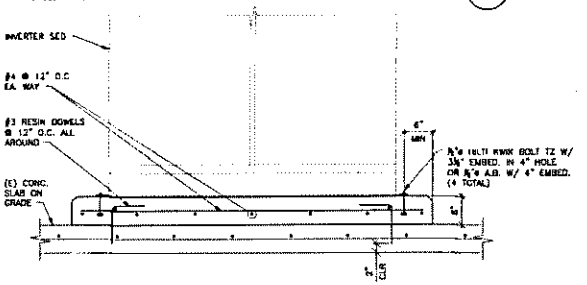
INVERTER PLAN (4)

SCALE: 1"=1'-0"


INVERTER SED
(E) 6" CONC. SLAB ON GRADE V.I.F.
⅝"ø HILTI KWIK BOLT TZ (4 TOTAL) W/3⅜" EMBED. IN 4" HOLE FOLLOW MANUFACTURER'S SPECIFICATIONS
NOTE: CONTRACTOR TO VERIFY DEPTH THICKNESS OF EXISTING SLAB – DRILL PILOT HOLE TO CONFIRM THICKNESS. IF LESS THAN 6" FOLLOW ALTERNATE DETAIL & WITH PAD.

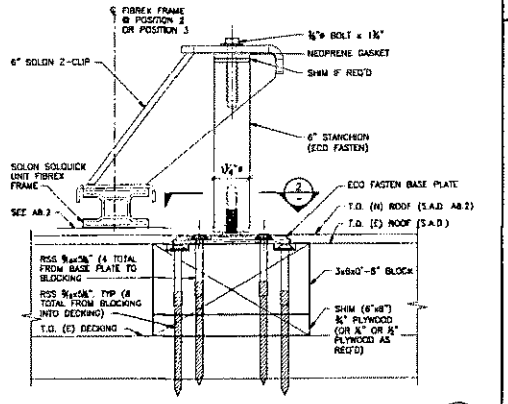
INVERTER ANCHORAGE DETAIL (5)

SCALE: 1"=1'-0"


INVERTER SED
#4 @ 12" O.C. EA. WAY
#3 RESIN DOWELS @ 12" O.C. ALL AROUND
(E) CONC. SLAB ON GRADE
⅝"ø HILTI KWIK BOLT TZ W/ 3⅜" EMBED. IN 4" HOLE OR ⅝"ø A.B. W/ 4" EMBED. (4 TOTAL)
6" MIN
4" CLR

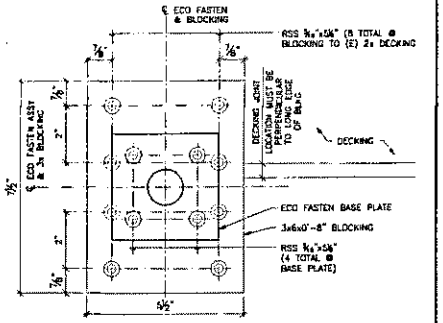
INVERTER HOUSE KEEPING PAD ALTERNATE DETAIL (6)

SCALE: 1"=1'-0"


FIBREX FRAME @ POSITION 2 OR POSITION 3
⅝"ø BOLT x 1¾"
NEOPRENE GASKET
SHIM 8" REQ'D
6" SOLON Z-CLIP
6" STANCHION (ECO FASTEN)
SOLON SOLQUICK UNIT FIBREX FRAME
SEE A8.2
ECO FASTEN BASE PLATE
T.O. (N) ROOF (S.A.D. A8.2)
T.O. (E) ROOF (S.A.D.)
RSS ⅜"ø x 5¾" (4 TOTAL FROM BASE PLATE TO BLOCKING
RSS ⅜"ø x 5¾" TYP (8 TOTAL FROM BLOCKING INTO DECKING)
T.O. (E) DECKING
3x6x0'-8" BLOCK
SHIM (6"x8") ¾" PLYWOOD (OR ½" OR ¾" PLYWOOD AS REQ'D)

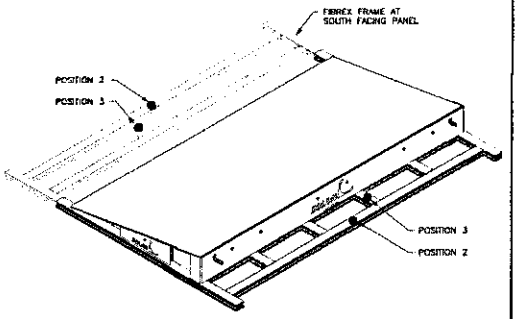
STANCHION DETAIL (1)

SCALE: 6"=1'-0"


℄ ECO FASTEN & BLOCKING
RSS ⅜"ø x 5¾" (8 TOTAL @ BLOCKING TO (E) 2x DECKING
DECKING JOINT LOCATED AT 90° PERPENDICULAR TO LONG EDGE OF BLK
DECKING
℄ ECO FASTEN & ADD'L 2x BLOCKING
ECO FASTEN BASE PLATE
3x6x0'-8" BLOCKING
RSS ⅜"ø x 5¾" (4 TOTAL @ BASE PLATE)

BASE PLATE PLAN (2)

SCALE: 6"=1'-0"



STANCHION PLACEMENT (3)

SCALE: 1"=1'-0"

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Structural Design and Engineering

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

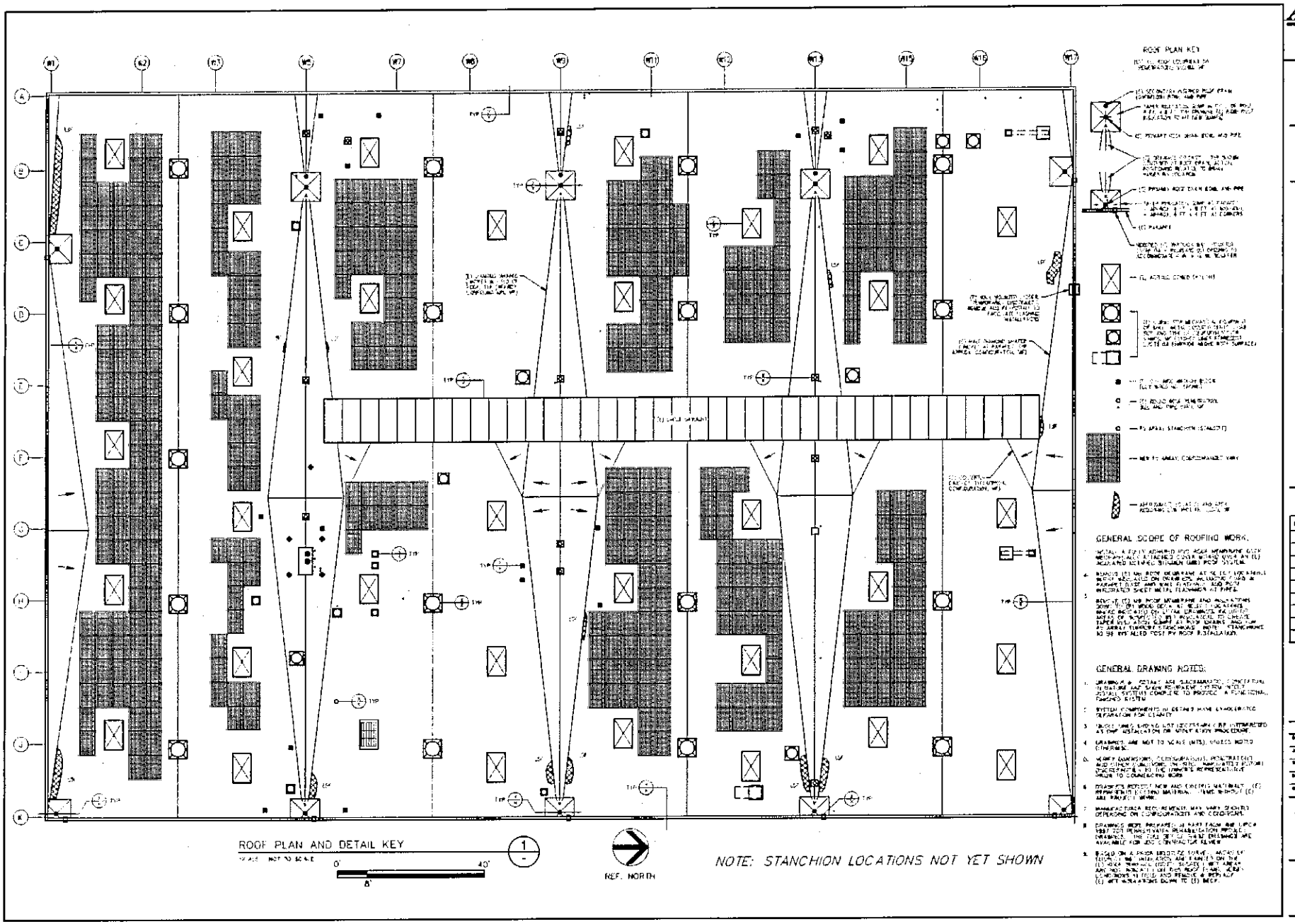
SCHEDULE	5/1/13	A

2/22/13

NONE

STRUCTURAL DETAILS

S7.1



APPC Group LLC

TM

TRS

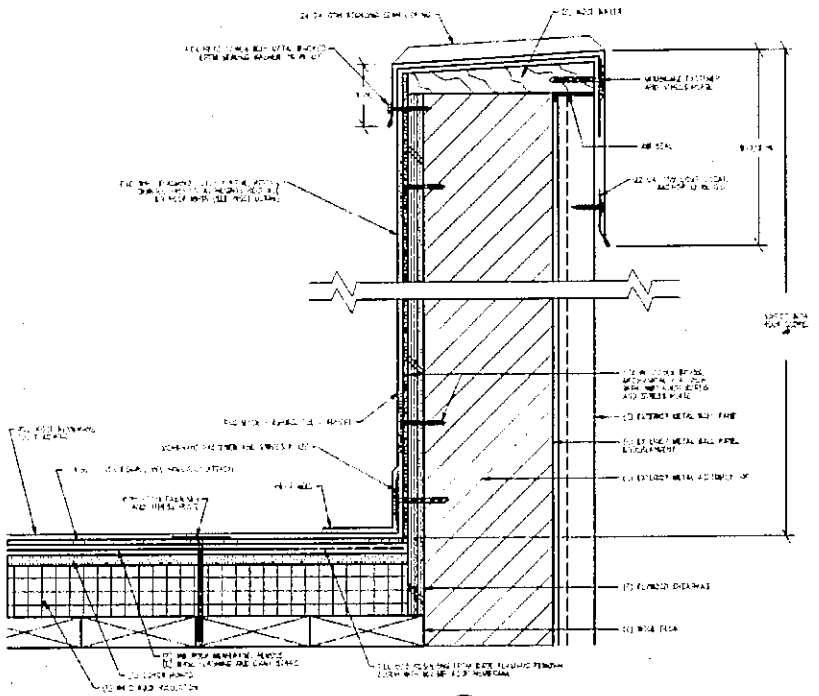
MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

BID REVIEW	3/1/13	A

Date	3/25/13
Job	BPPV-13008
Scale	N.T.S.
Drawn By	BD
Checked By	AK

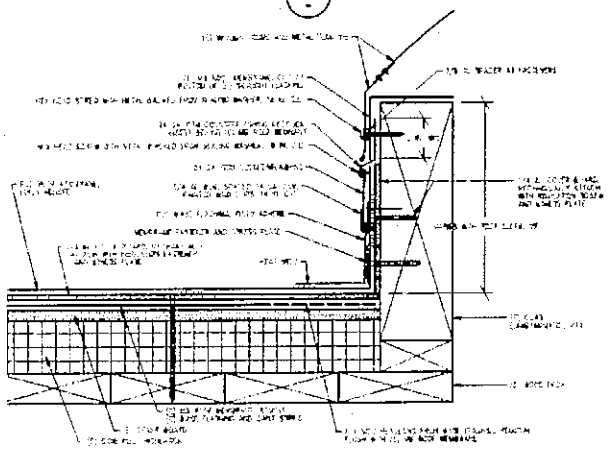
ARCHITECTURAL ROOF PLAN & DETAIL KEY

A1.1



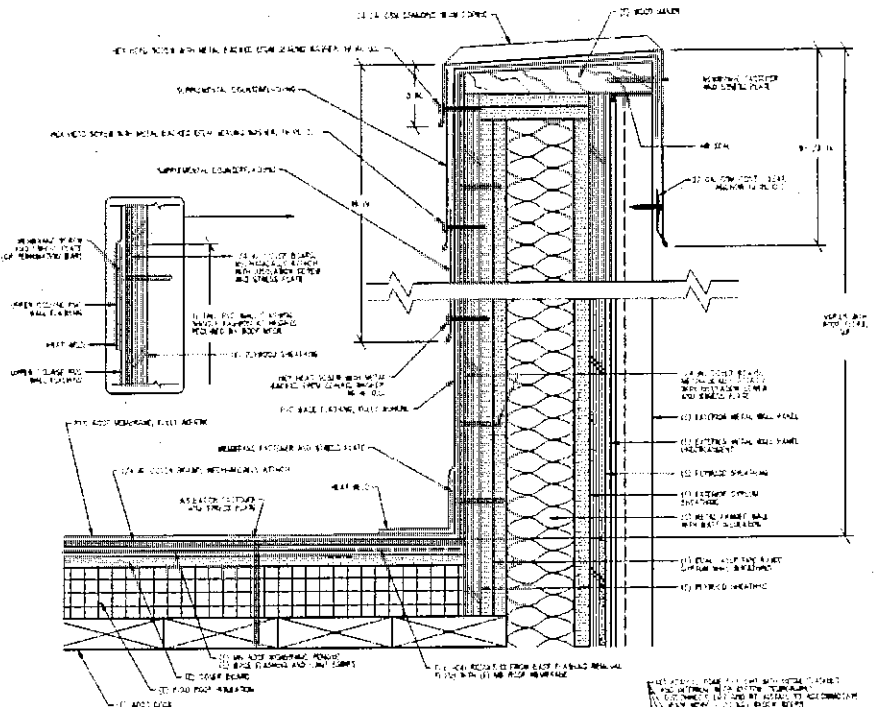
FLASHING @ PARAPET (NON-2 HR. FIRE RATED) 2

SCALE: NOT TO SCALE



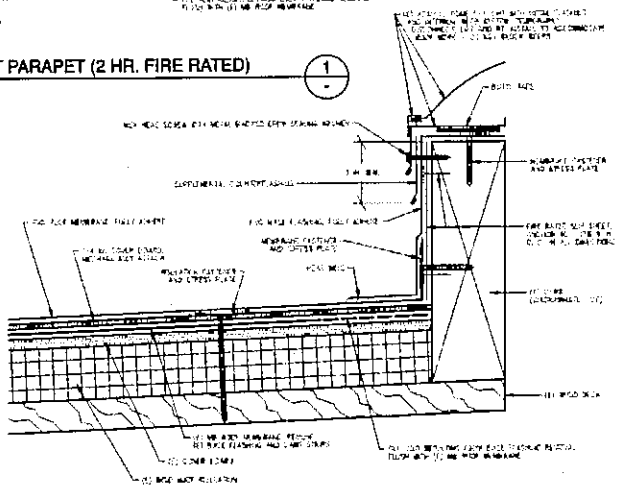
FLASHING @ LARGE SKYLIGHT 4

SCALE: NOT TO SCALE



FLASHING @ WEST PARAPET (2 HR. FIRE RATED) 1

SCALE: NOT TO SCALE



FLASHING @ SMALLER SKYLIGHT 3

SCALE: NOT TO SCALE

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PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

BID REVIEW	3/1/13	A

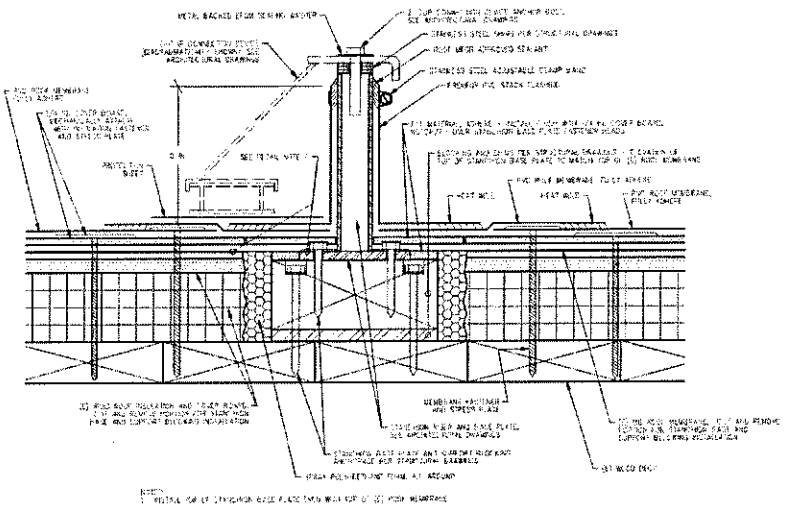
SHEET INFORMATION

Date	2/25/13
Job	SFPU-13006
Scale	N.T.S.
Drawn By	BD
Checked By	AA

ARCHITECTURAL FLASHING DETAILS

SHEET

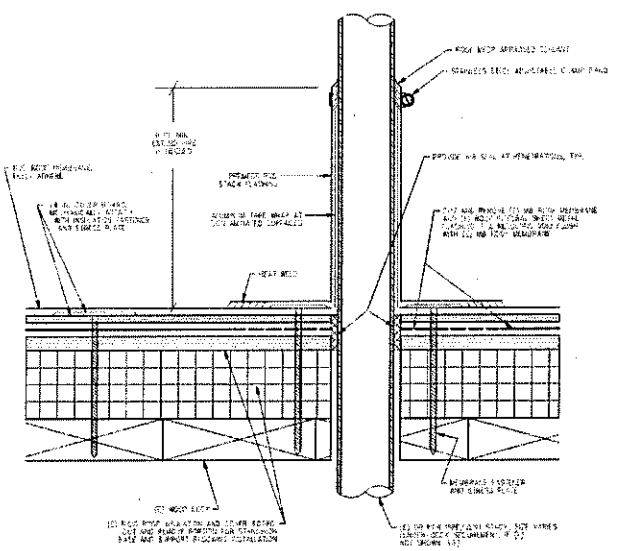
A8.1



FLASHING @ STANCHION (STANDOFF)

SCALE: NOT TO SCALE

1



FLASHING @ PIPE / VENT STACK

SCALE: NOT TO SCALE

2

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MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SDS REVIEW	3/1/13	A

SHEET INFORMATION

Date	2/22/13
Job	SFPU-13008
Scale	N.T.S.
Drawn	SC
Checked By	AK

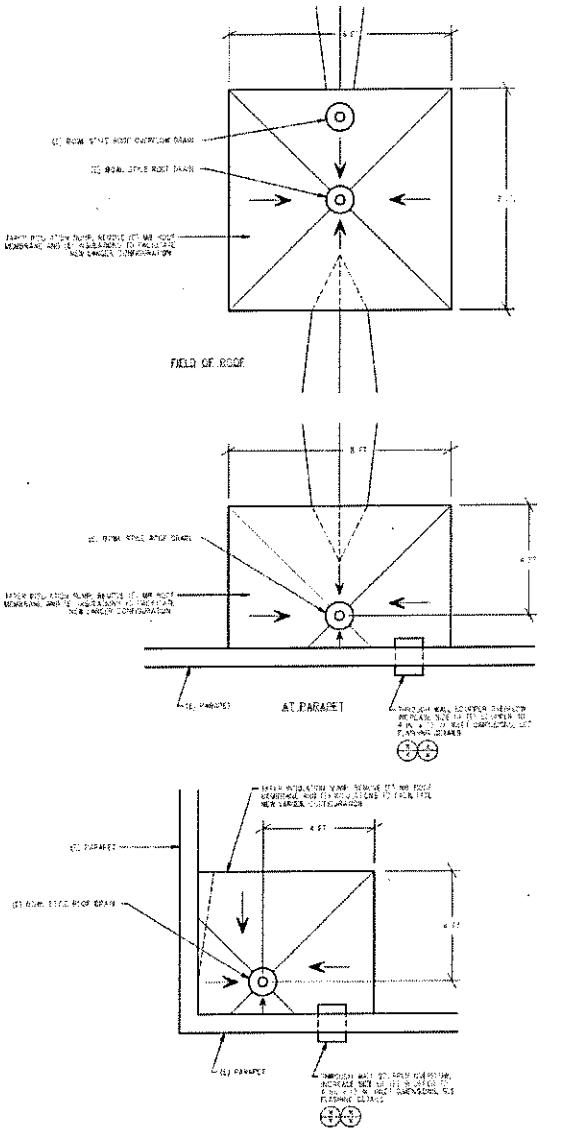
TITLE

ARCHITECTURAL FLASHING DETAILS

SHEET

A8.2

OF SHEETS



TAPER INSULATION SUMP CONFIGURATIONS (1)

SCALE: NOT TO SCALE

AEPC Group, LLC

TM

TRS

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

50% REVIEW	3/1/13	A

SHEET INFORMATION

Date	3/25/13
Job	SFPU-13008
Scale	N.T.S.
Drawn	BC
Checked By	AK

ARCHITECTURAL
TAPER
SUMP
CONFIGURATIONS

SHEET
A8.3

ELECTRICAL SYMBOLS (NOT ALL SYMBOLS APPLICABLE)

- (n) — CONSTRUCTION NOTE
- (#) — LIGHT FIXTURE IDENTIFICATION TAG
- S_x — LOWER CASE LETTER = SWITCH LEG
  D = DIMMER SWITCH; M = MOTOR RATED SWITCH
  DL = DATALINE SWITCH; TS = DIGITAL TIMER SWITCH
  K = KEY SWITCH; S = OCCUPANCY SENSOR SWITCH
  3 = 3 WAY SWITCH, 4 = 4 WAY SWITCH
- POWER OUTLET SEE DRAWING FOR RATING & TYPE (1PH)
- POWER OUTLET SEE DRAWING FOR RATING & TYPE (3PH)
- RECEPTACLE, DUPLEX 20A, 125V, 1Ø, STRAIGHT BLADE, NEMA 5-20R
- CEILING MOUNTED DUPLEX AND QUAD RECEPTACLES
- RECEPTACLE, DOUBLE DUPLEX 20A, 125V, 1Ø, STRAIGHT BLADE, NEMA 5-20R
- DUPLEX RECEPTACLE WITH GROUND FAULT CIRCUIT INTERRUPTER WHERE INDICATED ABOVE COUNTER, INSTALL AT +6" ABOVE COUNTER, UON.
- FLUSH FLOOR BOX WITH DUPLEX RECEPTACLE AND COMPARTMENT FOR 2-DATA OUTLETS.
- RECESSED PANELBOARD
- SURFACE PANELBOARD
- DISTRIBUTION PANELBOARD OR SWITCHGEAR
- LCP — LIGHTING CONTROL PANEL
- ELECTRIC CONDUIT RUN EXPOSED OR CONCEALED IN WALLS, OR ABOVE CEILING WHERE WALLS AND CEILING PERMIT.
- LOW VOLTAGE WIRING (50V OR BELOW)
- GROUND GRID
- CONDUIT RUN BELOW GRADE OR FLOOR
- CONDUIT UP/DOWN
- CONDUIT STUBBED OUT AND CAPPED
- EYS EXPLOSION PROOF FITTING
- FLEX CONDUIT
- HAND HOLE
- MAN HOLE
- JUNCTION OR OUTLET BOX WITH BLANK COVER – 4S UNLESS OTHERWISE NOTED

3#4 - 1D — DESTINATION (PANEL-CIRCUIT NO.)
CONDUIT (3/4" MIN U.O.N.)
GROUND CONDUCTOR } #12 WIRE U.O.N
NEUTRAL CONDUCTOR } NO HASH MARKS INDICATE
HOT CONDUCTORS } 2#12 AND 1#12 GND.

DISCONNECT SWITCH (LOCKABLE), NON-FUSED/FUSED.
3-POLE, NEMA 1 U.O.N.
15 — FUSE SIZE, NF FOR NON-FUSE
30 — DISCONNECT RATING
POLES

COMBINATION MOTOR STARTER WITH NON-FUSED/FUSED CIRCUIT BREAKER DISCONNECT (LOCKABLE)
15 — FUSE SIZE, NF FOR NON-FUSE
M — N=CONTROLLER NEMA SIZE, UON
30 — DISCONNECT RATING
POLES

- VFD
- VFD WITH BYPASS
- GROUND ROD
- TEST WELL
- AIR TERMINAL – 1/2"x24" w/CENTER SUPPORT

GENERAL ELECTRICAL NOTES

G1. ALL WORK SHALL COMPLY WITH THE NEC 2008/CEC 2010 OR LATEST EDITION OF THE ELECTRICAL CODE AND ALL OTHER APPLICABLE FEDERAL, STATE, AND LOCAL CODES. WHERE THE PLANS SHOW MORE RESTRICTIVE REQUIREMENTS, THE PLANS SHALL GOVERN, BUT NOTHING ON THESE PLANS SHALL BE INTERPRETED AS AUTHORITY TO VIOLATE ANY CODE OR REGULATION.

G2. ALL MATERIALS AND EQUIPMENT SHALL BE NEW AND SHALL BEAR THE UNDERWRITERS' LABORATORY LABEL (UL) AND SHALL BE INSTALLED IN THE MANNER FOR WHICH THEY ARE DESIGNED AND APPROVED.

G3. UNLESS OTHERWISE NOTED, ALL WIRE SHALL BE COPPER, STRANDED ONLY, UL LISTED, RATED FOR 600 VOLTS, TYPE THWN/THWN, MIN. 12 AWG MINIMUM FOR POWER AND #14 AWG MINIMUM FOR CONTROL. USE XHHW TYPE FOR #6 OR LARGER. USE RHW-2 OR USE-2 FOR STRING WIRING EXPOSED TO SUN AND OPEN CABLE TRAYS.

G4. PROVIDE RGC UP TO 8' AFF WHERE EXPOSED AND INDOORS. EMT CONDUIT TYPE FOR ALL OTHER AREAS LOCATED INDOORS. IN ADDITION USE RGC FOR OUTDOORS ABOVE GRADE, AND PVC SCHEDULE 40 FOR OUTDOORS UNDERGROUND. IN ADDITION, OUTDOOR UNDERGROUND CONDUIT RISERS AND 90 DEG BENDS CONDUITS SHALL BE RGC. UNDERGROUND RGC SHALL BE WRAPPED WITH 20 MIL TAPE AND EXTEND 12" ABOVE GRADE FOR RISERS. USE MIN 3/4" CONDUIT, U.O.N.

G5. THE CONTRACTOR SHALL INSTALL ALL CONDUITS AND WIRES WITH A MINIMUM NUMBER OF BENDS AND IN SUCH A MANNER AS TO CONFORM TO THE STRUCTURE, AVOID OBSTRUCTIONS, PRESERVE HEAD ROOM, KEEP OPENINGS AND PASSAGEWAYS CLEAR, AND MEET ALL STRUCTURAL CODE REQUIREMENTS.

G6. NOT USED.

G7. THE ENTIRE ELECTRICAL INSTALLATION SHALL BE GROUNDED AS REQUIRED BY ALL APPLICABLE CODES. ALL CONDUIT RUNS SHALL INCLUDE A CODE SIZED GROUND WIRE WHETHER OR NOT SO INDICATED.

G8. ALL BRANCH CIRCUITS SHALL INCLUDE A CODE SIZED GROUND WIRE. ISOLATED/DEDICATED BRANCH CIRCUITS SHALL INCLUDE A SEPARATE GROUND WIRE CONNECTED TO THE DESIGNATED SINGLE POINT GROUND FOR EACH SUPPLIER OUTLET ON A CIRCUIT.

G9. CERTAIN FEEDER AND BRANCH CIRCUIT WIRE SIZES HAVE BEEN OVERSIZED TO COMPENSATE FOR VOLTAGE DROP. SPLICE WIRES TO COMPATIBLE SIZES FOR TERMINATION, ADJACENT TO EQUIPMENT CONNECTION AS REQUIRED. SHAVING OF CABLE STRAND NOT ALLOWED.

G10. ALL TERMINATION POINTS WILL HAVE SCREW-IN, CLAMP-TYPE CONNECTIONS, UNLESS OTHERWISE PRIOR APPROVAL IS GIVEN BY ENGINEER.

G11. THE ENTIRE WIRING SYSTEM TO BE TESTED FOR SHORT CIRCUITS, GROUNDS, AND INSULATION RESISTANCE BETWEEN CONDUCTORS AND TO GROUND.

G12. THE CONTRACTOR SHALL PROVIDE SUPPORT FOR ALL ELECTRICAL EQUIPMENT TO COMPLY WITH THE SEISMIC REQUIREMENTS OF THE UNIFORM BUILDING CODE AND ALL LOCAL ORDINANCES.

G13. PROVIDE A NAMEPLATE FOR EACH INDIVIDUALLY MOUNTED CIRCUIT BREAKER OR DISCONNECT SWITCH, ELECTRICAL PANELS, TRANSFORMERS, DISTRIBUTION BOARDS, ETC, PULL BOX, AIRTITE RECEPTACLE, AND FOR ANY OTHER CONTROL DEVICE OR MAJOR ITEM OF ELECTRICAL EQUIPMENT AS FOLLOWS:

1 --- PROVIDE LAMINATED NAMEPLATES ENGRAVED IN 1/4" HIGH LETTERS TO CORRESPOND WITH THE DESIGNATION ON THE DRAWINGS. PROVIDE OTHER OR ADDITIONAL INFORMATION ON NAMEPLATES WHERE INDICATED. ORANGE FOR 480V.

2 --- ATTACH NAMEPLATES TO EQUIPMENT WITH RIVETS, BOLTS, OR APPLICABLE SHEET METAL SCREWS. GLUE-ON TYPES AND POP-RIVETS TYPE ARE NOT ACCEPTABLE.

LABEL ALL RECEPTACLES, OUTLETS, JUNCTION BOXES, WITH DYMO-TYPE EMBOSSED TAPE AS FOLLOWS:

1 --- RECEPTACLES AND JUNCTION BOXES: PANEL AND CIRCUIT NUMBER.

2 --- USE BLACK TAPE FOR 240V AND LESS.

3 --- USE ORANGE TAPE FOR 277V AND ABOVE.

INDICATE ON THE DEVICE IF THE CIRCUIT IS DEDICATED OR ISOLATED.

G14. THE ELECTRICAL DRAWINGS ARE DIAGRAMMATIC AND DO NOT SHOW ALL OFFSETS, BENDS, FITTINGS, JUNCTION BOXES, PULL BOXES, AND EXPANSION FITTINGS REQUIRED TO MEET FIELD CONDITIONS. CONTRACTOR SHALL DETERMINE ACTUAL MATERIAL AND HARDWARE REQUIREMENTS AND VERIFY ALL DIMENSIONS.

G15. CONTRACTOR SHALL PROVIDE PULL LINE IN ALL EMPTY CONDUITS.

G16. FUNCTIONALLY TEST THE ELECTRICAL INSTALLATION FOR PROPER OPERATION AND ROTATION.

G17. FURNISH AND INSTALL ALL CONDUITS, WIRES, BOXES, SWITCHES, LIGHT FIXTURES (WITH LAMPS), RECEPTACLES, SERVICE DEVICES, PANELBOARDS AND OTHER EQUIPMENT SHOWN ON THE DRAWINGS AS REQUIRED FOR A COMPLETE AND OPERATIONAL ELECTRICAL SYSTEM.

G18. PROVIDE COLOR CODED AS SHOWN:
COLOR CODE WILL BE CARRIED THROUGHOUT ALL BRANCHES ON A SINGLE CIRCUIT.

APPLICATION	COLOR CODING
1. 3-PHASE – 480/277 VOLT	A = BROWN B = ORANGE C = YELLOW NEUTRAL = GREY GROUND = GREEN
2. 3-PHASE – 120/208 VOLT	A = BLACK B = RED C = BLUE NEUTRAL = WHITE GROUND = GREEN
3. 1-PHASE – 120 VOLT ISOLATED CIRCUIT (ORANGE RECEPTACLE ONLY)	HOT = ORANGE NEUTRAL = WHITE GROUND = GREEN
4. 1-PHASE – 120 VOLT CIRCUIT	HOT = BLACK, RED, OR BLUE DEPENDING ON PHASE NEUTRAL = WHITE

G19. SUBMIT TO THE ENGINEER SHOP DRAWINGS, MANUFACTURER'S DATA AND CERTIFICATES FOR EQUIPMENT, MATERIALS AND FINISH, AND PERTINENT DETAILS FOR EACH SYSTEM SPECIFIED. OBTAIN APPROVAL BEFORE PROCUREMENT, FABRICATION, OR DELIVERY OF THE ITEMS TO THE JOB SITE. PARTIAL SUBMITTALS ARE NOT ACCEPTABLE AND WILL BE RETURNED WITHOUT REVIEW.

G20. ALL ELECTRICAL EQUIPMENT INSTALLED OUTDOORS SHALL BE WEATHERPROOF, MINIMUM OF NEMA 3R RATING. EXTERIOR CONDUIT RUNS INTO BUILDINGS SHALL BE INSTALLED WITH FLASHING, CAULKED AND SEALED. CONDUITS FOR EXTERIOR ELECTRICAL DEVICES SHALL BE RUN INSIDE BUILDING, UON.

GROUNDING NOTES

GD1. ALL GROUND GRID CONDUCTORS ARE #4/0 SOFT DRAWN BARE COPPER.

GD2. GROUND RODS SHALL BE MIN 10 FEET IN LENGTH, 3/4" DIAMETER, AND COPPER CLAD.

GD3. CONNECTIONS TO GROUND RODS SHALL BE EXOTHERMIC TYPE. TEST WELL CONNECTIONS SHALL BE BOLTED TYPE.

GD4. THE CONTRACTOR SHALL MAKE GROUND RESISTANCE MEASUREMENTS AS REQUIRED BY THE LATEST EDITION OF CEC, DOCUMENT THE READINGS AND REPORT THEM TO THE ENGINEER.

GD5. MAJOR EQUIPMENT SHALL BE CONNECTED TO THE GROUND GRID BY TWO CONNECTIONS FROM DIFFERENT PARALLEL MAIN GRID CONDUCTORS.

GD6. WHEN AN EXPOSED GROUND CABLE IS RUN IN METAL CONDUIT OR PROTECTED BY A METAL GUARD; THE GROUND CABLE SHALL BE BONDED AT BOTH ENDS TO THE CONDUIT OR THE GUARD.

GD7. UNLESS OTHERWISE NOTED, BURIED GROUNDING CONDUCTORS SHALL HAVE A MINIMUM OF TWO FEET OF COVER (24").

GD8. ALL JUNCTIONS MADE ABOVE GROUND OR IN TEST WELLS SHALL BE BOLTED CONNECTIONS, EXCEPT THOSE AT BUILDING COLUMNS WHICH MAY BE EITHER BOLTED OR EXOTHERMIC TYPES.

ELECTRICAL ABBREVIATIONS

A	AMPERE
AFF/AFG	ABOVE FINISHED FLOOR/ABOVE FINISHED GRADE
AV	AUDIO VISUAL
ATS	AUTOMATIC TRANSFER SWITCH
BLDG.	BUILDING
C	CONDUIT
CAT	CATEGORY
CATV	CATV
CB	CIRCUIT BREAKER
CKT	CIRCUIT
CLG.	CEILING
CO	CONDUIT ONLY
COMM	COMMUNICATION
CU	COPPER
DIST	DISTRIBUTION
DWG	DRAWING
(E)	EXISTING
(ERL)	EXISTING TO BE RELOCATED
ELECT	ELECTRIC(AL)
EMT	ELECTRIC METALLIC TUBING
EP	EXPLOSION PROOF
(ER)	EXISTING TO REMAIN
F	FUSED
FA	FIRE ALARM
FACP	FIRE ALARM CONTROL PANEL
FIXT	FIXTURE
FLA	FULL LOAD AMPERES
FLEX	FLEXIBLE
FSS	FUSED SAFETY SWITCH
FT	FOOT OR FEET
G; GND	GROUND(ED)
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
HH	HAND HOLE
HOA	HAND-OFF-AUTOMATIC
HP	HORSEPOWER
HT	HEIGHT
IMC	INTERMEDIATE METAL CONDUIT
IDF	INTERMEDIATE DISTRIBUTION FRAME
JB	JUNCTION BOX
KAIC	AMPERE INTERRUPTING CAPACITY, IN THOUSANDS
LCP	LIGHTING CONTROL PANEL
LEL	LOWER EXPLOSION LEVEL
LDA	LIGHTING DESIGN ALLIANCE
LT(G)	LIGHT(ING)
MH	MAN HOLE
MCB	MAIN CIRCUIT BREAKER
MDF	MAIN DISTRIBUTION FRAME
MECH	MECHANICAL
MIN	MINIMUM
MLO	MAIN LUGS ONLY
MSB	MAIN SWITCHBOARD
MTD	MOUNTED
(N)	NEW
NE	NON ELECTRICAL
NEUT	NEUTRAL
NEC	NATIONAL ELECTRICAL CODE
NL	NIGHT LIGHT
NFSS	NON FUSED SAFETY SWITCH
NTS	NOT TO SCALE
OC	ON CENTER
OS	OCCUPANCY SENSOR
P	POLE
PNL	PANEL
PVC	POLYVINYL CHLORIDE
RECEPT	RECEPTACLE
REF	REFERENCE
(R)	RELOCATED
RGC	RIGID GALVANIZED STEEL CONDUIT
REQ	REQUIRED
RM	ROOM
SC	SHORT CIRCUIT
SM	MANUAL MOTOR SWITCH
SPC	SPACE
SPEC	SPECIFICATION(S)
SPR	SPARE
SWGR	SWITCHGEAR
SWBD	SWITCHBOARD
TCP	TEMPERATURE CONTROL PANEL
TEL	TELEPHONE
TTB	TELEPHONE TERMINAL BACKBOARD
TYP	TYPICAL
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSER
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SUPPLY
UTY	UTILITY
VFD	VARIABLE FREQUENCY DRIVE
W/	WITH
WP	WEATHERPROOF
XFMR/TR	TRANSFORMER

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TRS

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SUBMISSION	3/1/13	A

SUBMISSION INFORMATION
Date: 2/22/13
Job: SFPU 13006
Issue: 4/29
Drawn: SC
Checked By: TM

ELECTRICAL SYMBOLS, GENERAL NOTES, ABBREVIATIONS

E0.1

SECTION 16000
ELECTRICAL GENERAL SPECIFICATION

PART 1 — GENERAL

1.01 CONDITIONS AND REQUIREMENTS
A. Refer to the General Conditions, Supplementary General Conditions as required.

1.02 SCOPE OF WORK
A. Furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on the drawings and/or specified in Division 16 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete installation including all accessories and appurtenances required for testing the system. It is the intent of the drawings and specifications that all systems be complete and ready for operation.
B. Definitions (Applicable to Drawings and Specifications):
1. Above Grade: Not buried in ground and not embedded in concrete slab on grade.
2. Below Grade: Buried in ground or embedded in concrete slab on grade.
3. Concealed: Inside building above grade and located within walls, furred spaces, crawl spaces, attics, above suspended ceilings, etc. In general, any item not visible or directly accessible.
4. Connect: Complete hookup of items with required services, including conduit, wires, plugs, receptacle, and other accessories.
5. Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms. In general, any item that is directly accessible without removing panels, walls, ceilings, or other parts of structure.
6. Furnish: Supply and deliver complete.
7. Install: Place, secure, and connect as required to make fully operational.
8. Provide: Furnish and install as defined above, perform work.
9. Underground: Buried in ground, including under building slabs.
10. Use (Verb): Furnish and install as defined under "provide."
11. Work: Electrical raceway, conductors, and connections.

1.03 CODE COMPLIANCE
A. All work and materials shall comply with the latest rules, codes, and regulations, including, but not limited to the following:
1. Occupational Safety and Health Act Standards (OSHA).
2. California Electrical Code (CEC)
3. Certified Ballast Manufacturers (CBM).
4. Underwriters Laboratories (UL) Standard:
5. 935 Standard for Fluorescent-Lamp Ballasts.
6. 1598 Luminaries.
7. NFPA #70: National Electrical Code (NEC).
8. NFPA #101: Life Safety Code.
9. Code of Federal Regulations (CFR):
10. 29 CFR 1910.147 Control of Hazardous Energy (Lock Out/Tag Out).
11. Electronics Industries Association (EIA).
12. Institute of Electrical and Electronics Engineers (IEEE).
13. National Electrical Testing Association (NETA).
14. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, Standard ATS.
15. National Electrical Manufacturers Association (NEMA).
16. Occupational Safety and Health Act (OSHA) Standards.
17. State of California Public Utilities Commission:
18. General Order 128 Rules for Construction of Underground Electric Supply and Communication Systems.
19. All other applicable Federal, State, and Local laws and regulations.
B. Code compliance is mandatory. Nothing in these drawings and Specifications permits work not conforming to these codes. Where work is shown to exceed minimum code requirements, comply with drawings and specifications.
C. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, the Contractor shall be responsible for all work required opening and restoring the concealed areas in addition to all required modifications.

1.04 LICENSE, FEES AND PERMITS
A. Arrange for required inspections and pay all license, permit, and inspection fees.

1.05 CONDITIONS AT SITE
A. Visit to site is required of all bidders prior to submission of bid. All bidders are required to familiarize themselves with all conditions and no extra payment will be allowed for such work required because of these conditions, whether specifically mentioned or not.
B. Lines of other services that are encountered as part of this work shall promptly be repaired at no expense to the Owner to complete satisfaction of the Owner.

1.06 DRAWINGS AND SPECIFICATIONS
A. All drawings and all Divisions of these specifications shall be considered as a whole and work of the Division shown anywhere therein shall be furnished under this Division.
B. Drawings are diagrammatically and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assumed. Exact requirements shall be governed by architectural, structural and mechanical conditions and the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc. necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.
C. Right is reserved to make changes of up to 10' in location of any outlet or equipment prior to roughing in without increasing contract cost.

1.07 SAFETY AND INDEMNITY
A. Safety: Refer to General Conditions, Division 01
B. Indemnity: Refer to General Conditions, Division 01
Or
A. Safety: The Contractor shall be solely and completely responsible to conditions of the job site, including safety of all persons and property during performance of the work. These requirements will apply continuously and not be limited to normal working hours. No act, service, drawing review, or construction review by the Owner, the Architect/Engineer, or their Consultants, is intended to include review of the adequacy of the Contractor's safety measures, in, on, near the construction site.
B. Indemnity: The Contractor will hold harmless, indemnify, and defend the Owner, the Architect/Engineer, their Consultants, and each of their officers, employees and agents, from any and all liability claims, losses or damage arising or alleged to arise from the performance of the work described herein, but not including the sole negligence of the Owner, the Architect/Engineer, and their Consultants, and each of their Officers, Employees and agents.

1.08 RECORD DRAWINGS
A. Contractor shall obtain a complete record set of reproducible drawings from the Architect/Engineer. This shall be corrected daily to show all changes from original contract drawings and shall be kept on the job. This set of reproducible drawings and neatly marked, shall be delivered to the Architect/Engineer upon completion of the job.

1.09 GUARANTEE
A. Guarantee the installation free from defects of workmanship and materials for a period of one (1) year after Date of Certificate of Final Payment, and promptly remedy any defects developed during the period, without charge.

1.10 ACCEPTANCE DEMONSTRATION
A. Upon completion of the work, at a time to be designated by the owner, the Contractor shall demonstrate for the owner the operation of the electrical installation, including any and all special items installed by him or installed under his supervision.

1.11 SUBSTITUTIONS
A. Wherever possible, more than one manufacturer has been listed for various items of equipment, any one of which will be acceptable. Where the bid on one of materials specified, if, after award of the Contract, a substitute is proposed, the request for permission to substitute shall be accompanied with a statement of the amount of money to be returned to the contract if the substitution is permitted. The Owner's Architect/Engineer is the sole judge of acceptability of proffered substitutions. If a substitute item is permitted, and any redesign effort is thereby necessitated, the required redesign shall be at the Contractor's expense.

1.12 SHOP DRAWINGS
A. Submit shop drawings and product descriptive literature for review
B. All proposed deviations from specifications must be clearly listed under a prominent heading entitled "DEVIATIONS"
C. Purpose of review of submittals is for check of general compliance with information given in contract documents. Each review and/or addition of notations and comments does not relieve Contractor from compliance with requirements of project contract documents.
D. Contractor shall be responsible for conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction. Where dimensions of proposed equipment differ significantly from that shown on contract documents, Contractor shall submit revised drawings showing proposed layout of equipment with shop drawing submittal.

1.13 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS
A. Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
B. Provide foremen to be in charge of this work at all times.

1.14 COORDINATION
A. Coordinate work with other trades to avoid conflict and to provide correct rough in and connection for equipment furnished under other trades that requires electrical connections. Inform Contractors of other trades of required access to and clearances around electrical equipment to maintain serviceability and code compliance.
B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.

1.15 CUTTING AND PATCHING
A. All cutting and patching required for work of this Division is included herein. Coordination with General Contractor and other trades is required. Contractor shall bear the responsibility for the added expense of adjusting for improper holes, supports, etc.

1.16 EXISTING UNDERGROUND UTILITIES AND SERVICES
A. Locations of existing utilities, where shown, were established from best available information. Assume that this information is approximate. Contractor shall verify exact location and depths before starting work. Should, during the course of the work, conditions are found different than indicated, notify Architect/Engineer immediately. Use extreme caution so as not to damage or break lines that are in use. If breakage does occur, Contractor shall be responsible for all damage and repairs resulting therefrom. All unusual conditions with respect to existing facilities shall be brought to Architect/Engineer's attention immediately.

PART 2 — PRODUCTS

2.01 MATERIAL APPROVAL
A. All materials must be new and bear Underwriters' Laboratories label. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency.
B. Material not in accordance with these Specifications may be rejected either before or after installation.

2.02 CONDUITS AND OTHER RACEWAYS
A. Rigid Steel: Hot-dipped galvanized.
B. Intermediate Metal Conduit (IMC): Hot dipped galvanized.
C. Electrical metallic Tubing (EMT): Electro-galvanized.
D. Plastic: Schedule 40 PVC, approved for use as non-metallic raceway for 90 Deg C.
E. Wire way: Code gauge steel, with knockouts and hinged cover. Corrosion-resistant gray baked enamel finish.
F. Provide fittings and accessories approved for the purpose equal in all respects to the conduit or raceway. Use connectors and couplings shall be steel compression type.
G. Manufacturer: Carlon or approved equal.

2.03 WIRES AND CABLES
A. For power and lighting systems 600 volts or less:
1. Conductor: #12 AWG and larger shall be stranded copper. Minimum size shall be #12 AWG.
2. Insulation Type: #12 AWG to #6 AWG shall be THWN/THHN for wet or underground locations and THHN for dry locations. #4 through #1 AWG shall be Type XHHW (55 Mils). #250 MCM and larger shall be Type XHHW (65 Mils). Grounding wire shall be type TW.
B. For signal and communications circuits:
1. Special cables shall be as specified on drawings.
2. Conductors for general use shall be stranded copper conductor, #16 AWG minimum, with TYPE THHN insulation for underground or wet locations and Type THHN insulation for dry locations.
3. Acceptable Products: General Electric, Anaconda, Southwire, Okonite, Pirorette, Pirelli-General or Triangle products conforming or exceeding applicable IPCEA Standards.

2.04 OUTLET BOXES, JUNCTION BOXES, AND PULL BOXES
A. Outlet Boxes: Shall be hot-dipped, galvanized or sherardized of required size, 4" square, minimum, for flush mounted devices and lighting fixtures. Cast type with gasketed covers for outdoor or wet locations.
B. Junctions' Boxes and Pull Boxes: Use outlet boxes with appropriate covers as junction boxes wherever possible. Larger junction boxes and pull boxes shall be fabricated from sheet steel, sized according to code, with screw-on covers, finished gray baked enamel.
C. Manufacturer: Thomas and Betts or approved equal.

2.05 WIRING DEVICES
A. Wall Switches:
Totally enclosed, AC rated, self grounding, silent type, except as noted below. Numbers used below are those of Hubbell Equivalent Leviton, Bryant, or General Electric is acceptable.

Single Pole Switches:	#1221	20 Amperes	277 Volts.
Double Pole Switches:	#1222	20 Amperes	277 Volts.
Three-Way Switches	#1223	20 Amperes	277 Volts.

B. Duplex Convenience Receptacles: Three-pole grounded, rated 20 Amperes, 125 Volt, Hubbel Series 5362. Receptacles connected to emergency circuit shall be red in color.
C. Ground Fault Circuit Interrupter (GFCI) Receptacles: Three-Pole grounded, rated 20 Amperes, 125 Volt, Hubbel Series #GF5362. Provide TI-I hortie plate for indoor and weatherproof lift cover for outdoor installation.
D. Other special purpose receptacles shown on drawings shall be of same quality.
E. Telephone Outlets: 4" square box with one gang plaster ring and ¾" diameter one-hole plate.
F. Face Plates: Use ivory faceplates, unless otherwise noted on plans.
G. Device Plates: Satin finish stainless steel for flush and galvanized steel for all surface mounted devices except certain areas may require ivory or brown Bakelite plates and devices. Confirm finishes with architect before ordering. Weatherproof plates shall be stainless steel with hinged deep cover hood.

2.06 CONDUIT HANGERS
A. For individual conduit runs directly fastened to the structure, use rod hangers manufactured by Caddy, Unistrut or B-line.
B. For multiple in conduit runs use Unistrut or B-line trapeze type conduit support designed for maximum deflection not greater than ¼".

2.07 WIRE CONNECTORS
A. For wire sizes #8 AWG and smaller: Insulated pressure type (with live spring) rated 105 Deg C, 600 Volts, for building wiring and 1000 Volts in signs or fixtures. Scotchlok or equal.
B. For wires sizes #6 AWG and larger: T&B or equivalent compression type with 3M # 33+ or Plymouth "Polarnet Grey" tape insulation.

2.08 PANEL BOARDS
A. Construction: Cabinets shall be of code gauge, galvanized steel, door-in-door type surface or flush mounted as indicated. Doors shall be of code-rolled steel with concealed hinges and flush combination lock. All doors shall be keyed alike. Panels located adjacent to each other shall have identically sized enclosure and trims. Minimum panel width shall be 20". Finish equipment and backpans shall be painted one coat of light gray enamel at factory for overpainting in field where required.
B. Bus Bars: Copper. Provide minimum ¼ capacity ground block with full complement of terminals in addition to insulated (200% for 208/120V neutral bus. Future breaker spaces shall have complete provision including busses and connecting hardware.
C. Manufacturers: Panelboards shall be Square D equivalent products of Cutler-Hammer or General Electric.

2.09 CIRCUIT BREAKERS
A. Construction: Shall be quick-make, quick-break, molded case type, bolted type:
1. 120/208 Volt Panels: Shall be Square D NGDD or (-line, plug-in type with minimum 10,000 Amperes symmetrical interrupting capacity.
2. 277/480 Volt Branch Circuit panel Boards: Shall be Square D NF or I-line, bolted case bolt-on type designed for 277/480 Volt, three phase, four wire service with minimum 14,000 Amperes rms. symmetrical circuit rating.
3. Provide multi-pole units with common trip elements.
4. Breakers shall be quick-make, quick-break, over-toggest position in addition of the ON and OFF positions.
5. Provide lockouts for all circuits that should not be inadvertently turned off.
C. Name plates:
1. Provide engraved Bakelite nameplate identification on outside of each panel showing panel designation voltage and phase in minimum ¼" high letters.
F. Circuit Directories:
1. Provide a metal-framed circuit directory welded to inside of panel cover. Adhesive backed holders are not acceptable.
2. Provide typed directory card.

2.09 DISCONNECT SWITCH
A. General:
1. Disconnect switches shall be manufactured by Square D or approved equal.
B. TYPE
1. Disconnects (Motor: Non-Fused/Fused)
a. Lockable disconnect switches shall be provided and located at all motors.
b. Switches for three-phase motors shall be heavy-duty, three-pole, and fused/non-fused as shown on drawings.
c. Switches containing more than three poles shall be as specified on the drawings.
d. Switches for single-phase, fractional horsepower motors shall be lockable in the off position, toggle type, without overload protection and shall be horsepower rated.
e. Switches shall be horsepower rated.
2. Disconnects (Circuit: non-Fused/Fused)
a. Heavy-duty switches shall be type (number of poles) and rating (amperage and voltage), as indicated on the drawings.

PART 3 — EXECUTION

3.01 GENERAL
A. Electrical system layouts indicated on the drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of cable and wiring and the locations of outlets by the structure and equipment served.
B. Consult all other drawings. Verify scales and report any dimensional discrepancies or other conflicts to the Owner before submitting bid.
C. All homeruns to panel boards are indicated as starting from the outlet nearest the panel and continuing in the general direction of that panel. Continue such circuits to the panel as though the routes were completely indicated. Terminate homeruns of signal, alarm, and communications systems in a similar manner.
D. Avoid cutting and boring holes through structure or structural members whenever possible. Obtain prior approval of ARCHITECT/ENGINEER and conform to all structural requirements when cutting or boring the structure is necessary and permitted.
E. Furnish and install all necessary hangers, hangers, blocking, brackets, bracing, runners, etc. required for equipment specified under this section.
F. Provide necessary backing required ensuring rigid mounting of outlet boxes.

3.02 WIRING METHOD
A. Install all wiring in raceway, unless specifically shown otherwise.
B. Conduit shall be rigid steel, IMC, EMT, or plastic as follows:
1. Above ground: Use rigid steel, IMC, EMT.
a. Wet locations: Rigid steel or IMC only.
b. Hazardous locations: Rigid steel conforming to CEC requirements.
c. Locations subject to mechanical injury: Rigid steel or IMC only.
2. Underground: Use rigid steel wrapped with tape and ¼" overlap or use plastic
a. Rigid steel conduit shall be encased in 3" minimum concrete envelope and may be used for all services.
b. Plastic conduit size 2" or larger shall be encased in 3" minimum concrete envelope.
c. Plastic conduit size 1-1/2" and smaller shall be installed on 2" sand backfill. In planting areas provide 2" concrete cap. Multiple runs shall maintain 3" minimum separation between runs. Maintain 12" minimum of separation between power and signal conduits. Maintain 12" minimum of separation between medium voltage and low voltage power conduits.
3. Under building or building slabs: Use rigid steel wrapped with tape and ¼" overlap or plastic conduit.
a. Encase rigid steel conduit wrapped with tape and ¼" overlap in 3" minimum, concrete envelope.
b. Encase plastic conduit size 2" and larger in 3" minimum concrete envelop.
c. Install plastic conduit size 1-1/2" and small on 2" sandbase and cover with 2" and backfill. Maintain 3" minimum separation between runs. Do not install plastic conduit in rock.
d. Make all risers to grade with rigid steel conduit and rigid steel elbow fittings only. Complete entire run of steel conduit or fittings.
e. Burial depth of conduits shall be as follows:
1) Conduits encased: 24" minimum for 600 volt or lower systems to top of concrete encasement.
2) Concrete capped: 24" minimum to top of conduit.
3) Conduits not encased or capped: 24" minimum to top of conduit.
4) When installed under buildings the above minimum depth shall be 18" below bottom of floor slab.
C. Use flexible conduits in the followings applications:
1. Recessed lighting fixtures.
2. Motor connections.
3. Connection between fan plenum and structure.
4. At expansion joints.
5. At transformers and other equipment which produces vibration.
6. At wet locations, the flexible conduit shall be liquid tight type.

3.03 INSTALLATION OF CONDUITS
A. General:
1. Run all conduits concealed unless otherwise noted or shown.
2. Run exposed conduit parallel to or at right angles to centerlines of columns and beams.
3. Run in multiple in conduits use Unistrut or B-line trapeze type conduit support designed for maximum deflection not greater than ¼".
4. Install conduits above ceilings to avoid obstructing removal of ceiling tiles, lighting fixtures, air diffusers, etc.
5. Conduits shall not cross any duct shaft or area designated as future duct shaft horizontally. Conduit risers when allowed in duct shaft must be coordinated with mechanical work to avoid any conflict.
B. Conduit Supports:
1. Support conduit with UL's listed steel conduit supports at intervals required by the CEC. Wires or sheet metal straps are not acceptable for conduit support. Use conduit hangers for all conduits not directly fastened to structure and for all multiple conduit runs.
2. Individual conduits sizes ¾" and 1" may be supported from ceiling support wires with Caddy clips of any acceptable and best use. No conduits is permitted to be attached to any ceiling support wire.
3. Avoid bending conduit to fan plenums. When it is necessary to support conduit from fan plenum, provide a length of flexible conduit between portion attached fan plenum and portion attached to the building to minimize transmission of vibration to the building structure.
C. Conduit penetrations of roof, walls, floors and ceilings shall be sealed to preserve the integrity of waterproofing, fire rating and soundproofing, for when the roof, wall, floor, ceiling is designed. Materials and methods used shall conform to that specified Architect/Engineer sections.
D. All underground conduits and ducts size 2" and larger shall be proven clear by pulling through a mandrel ¼" smaller than the inside diameter.
E. Where flush branch circuit panel boards are shown on walls, stub a minimum of three 1" empty conduits in overhead ceiling spaces and three 1" conduits into space below floors (if any) in addition to conduits required for circuit wiring.

3.04 INSTALLATION OF WIRES
A. Pull no wire into any portion of the conduit system until all construction work, which might damage the wire, has been completed.
B. Install all wire continuous from outlet to outlet or terminal to terminal. Splices in cables when required shall be made in handholes, pull boxes, or junction boxes. Make branch circuit splices in outlet boxes with #1 or #2 directly color-coded set in accordance with manufacturer's recommendations.
C. Splices in wires and cables shall be made utilizing materials and methods described herein before.
D. All cables and wires passing through manholes and handholes shall be full looped inside the manhole and handhole and supported on fiberglass racks.
E. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to ground terminal of device when the device is not approved for grounding through the mounting screws.
F. Provide Engr wire markers where number of conductors in a box exceeds four.

3.05 WIRE COLOR CODE
A. Colors code all conductors. Wire sizes #8 AWG and smaller shall have integral color-coded insulation. Wire sizes #8 AWG and larger may have black insulation, but identified by color coded electrical tape at all junction, splice, pull or termination points. Color tape shall be approved ½ lap to least 6" of the conductor.
B. Color Code wires as follows:

Conductors	480/277V	480/277V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Isolated GND	Green w/ yellow stripes	Green w/ yellow stripes

3.06 CONNECTIONS TO EQUIPMENT
A. General
1. Furnish and install required power supply conduit and wiring to all equipment. See below for other wiring required.
2. Furnish and install a disconnect switch immediately ahead of and adjacent to each magnetic motor starter or as shown on drawings unless that motor appliance is located adjacent and within sight of the serving panel board, circuit breaker or switch. Verify all equipment nameplate current ratings prior to installation.
3. Install all motor starters and provide all power wiring to them, indicating those furnished under other section of specifications.
4. Install all roughing-in work for equipment from approved shop drawings to suit the specific requirements of the equipment.
5. Furnish and install all magnetic motor starters that are shown on the electrical drawings or specified under other divisions to be furnished under this Division of work. Verify equipment nameplate ratings prior to installation and furnish properly rated starters for the loads.
6. Furnish and install thermal overload protection for all motors not integrally equipped with thermal protection
7. Furnish 120 Volt power to each control panel and time switch requiring a source of power to operate
B. Heating, Ventilation and Air-Conditioning Equipment:
1. Line and low voltage temperature control and interlock wiring and conduit and required connections to complete equipment as part of other Division systems specifically shown or noted on the electrical drawings or to be furnished under this section.
2. Provide 120 Volt power supply to temperature control panels furnished and installed under other Divisions of work.
C. Plumbing and other Contract-Furnished and Owner Furnished Equipment:
1. All required power and control conduit, wiring and connections are included under this section of the work. Control sensing and alarm devices all be furnished under the respective section of the contract supplying the equipment unless noted otherwise. Where these are located in pipes, ducts, vessels, tanks, etc. they will be mounted in place by the Contractor furnishing the devices. All others shall be mounted under this section of work.
2. Control panels for packaged equipment will be furnished under the respective section of the contract supplying the equipment unless otherwise noted. Installation and connection of the control panels are under this section of the work.

3.07 IDENTIFICATION
A. Provide engraved, laminacoid name plates for switch gear, panels, motor starters, disconnect switches and all similar devices.
B. Provide dymo labels on all lighting switches and convenience and special purpose receptacles to show panel and circuit number to which the device is connected.
C. Provide label on all motors: "CAUTION: AUTOMATIC EQUIPMENT. MAY START AT ANY TIME."

3.08 GROUNDING
A. Electrical service and separately derived alternating current systems shall be grounded in accordance with NEC Article 250, inclusive.
B. Ground non-current carrying metal parts of electrical equipment enclosures, frames, conductor raceways or cable trays to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Equipment ground conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded.
C. Size grounding/bonding conductors per NEC Article 250-122 unless larger conductors are shown on drawings.
D. Size Grounding Electrodes/Service Entrance conductors per NEC article 250-66 unless larger conductors are shown on drawings.
E. Grounding conductors shall be identified with green insulation. Where green insulation is not available on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or device enclosure.

3.09 TESTING AND COMMISSIONING:
A. General Scope:
1. It is the intent of these tests to assure that all electrical equipment, both Contractor and Owner-supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.
B. Grounding
1. Conduct ground resistance tests using a ground resistance tester with a scale reading of 25 ohms maximum.
2. Test methods shall conform to IEEE Standard 81 using the three electrode method. Conduct test only after a period of not less than 48 hours of dry weather.
3. Take resistance readings for each ground rod individually and for each system as a whole without benefit of chemical treatment or other artificial means. Ground resistance readings shall not exceed 5 ohms. If the readings are over 5 ohms, provide lengthened or additional ground rods (maximum of three additional rods).
4. Submit a test report with recorded data at each ground rod location and each system the Engineer for Review.
C. Low Voltage Cable Tests:
1. Insulation Resistance Tests: Megger and record insulation resistances of all 600 volt insulated conductors using a 500 volt megger with a scale reading not less than 100 megaohms for one minute. Make tests with circuits isolated from source and load. The insulation resistance shall be 2 megaohms or more.
2. Submit a report to the Engineer certifying test.
3. Continuity Test of Wire: Test each wire for continuity and accuracy of the identifying tags at both ends and at all locations marked.
4. Submit a report to the Engineer certifying test.
D. Phase Rotation:
1. The contractor shall test and verify that the phase rotation of all new three-phase services, feeders and branch circuits matches the phase rotation of the existing circuits being replaced.
E. Equipment Testing:
1. Panelboards, switchboards, transformers, circuit breakers, and etc. Testing shall be in accordance with the Acceptance Testing Specification issued by National Electrical Testing Associate (NETA/ATS).

END OF SECTION 16000

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TRS

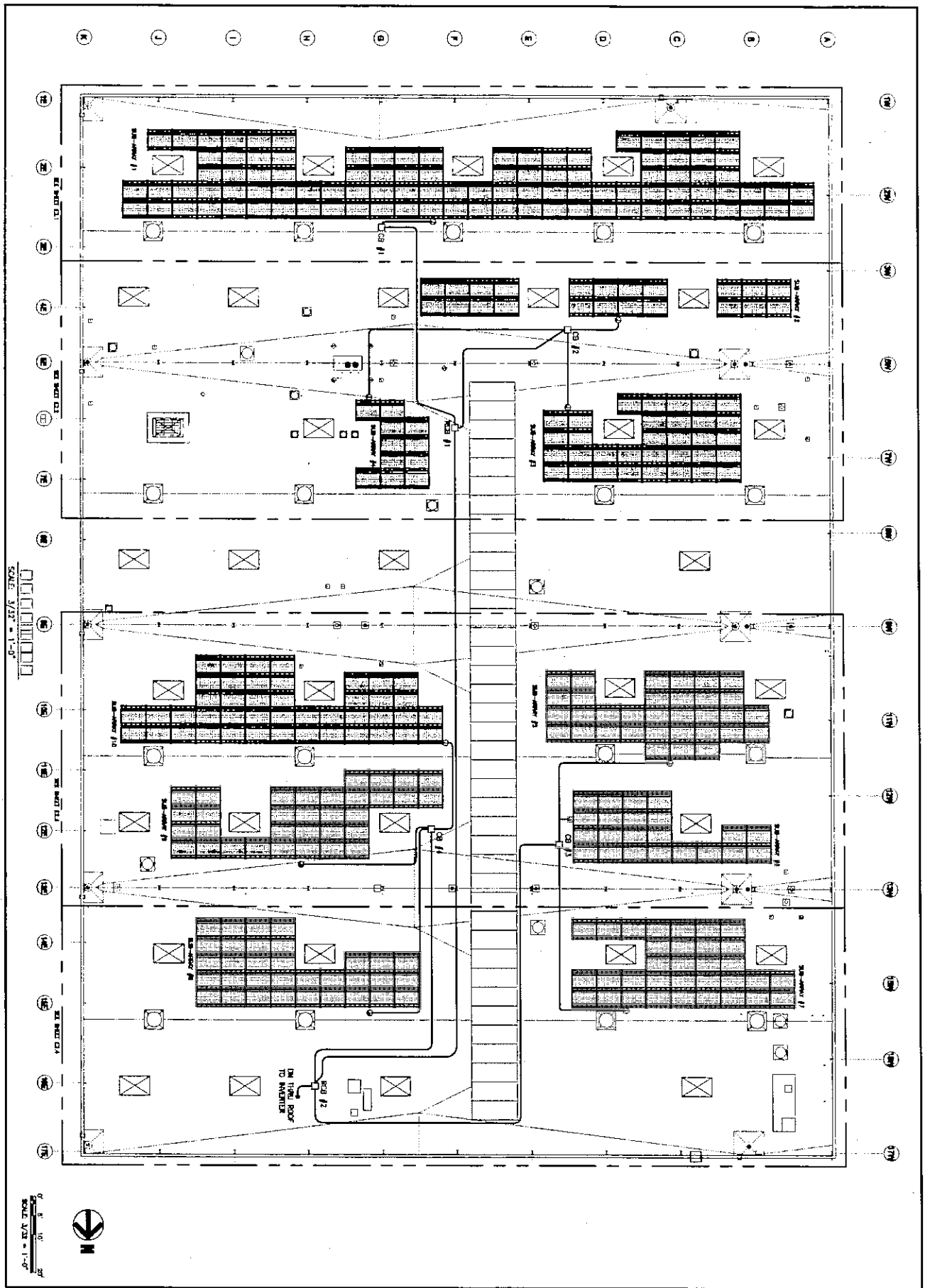
MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

NO.	REVISION	DATE	BY
	SCD REVIEW	2/27/13	A

SHEET INFORMATION
Date: 2/27/13
Job: 3478 13006
Scale: NONE
Drawn: SKS
Checked By: AK

ELECTRICAL SPECIFICATIONS

Sheet: E0.2
Of: 66175



MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

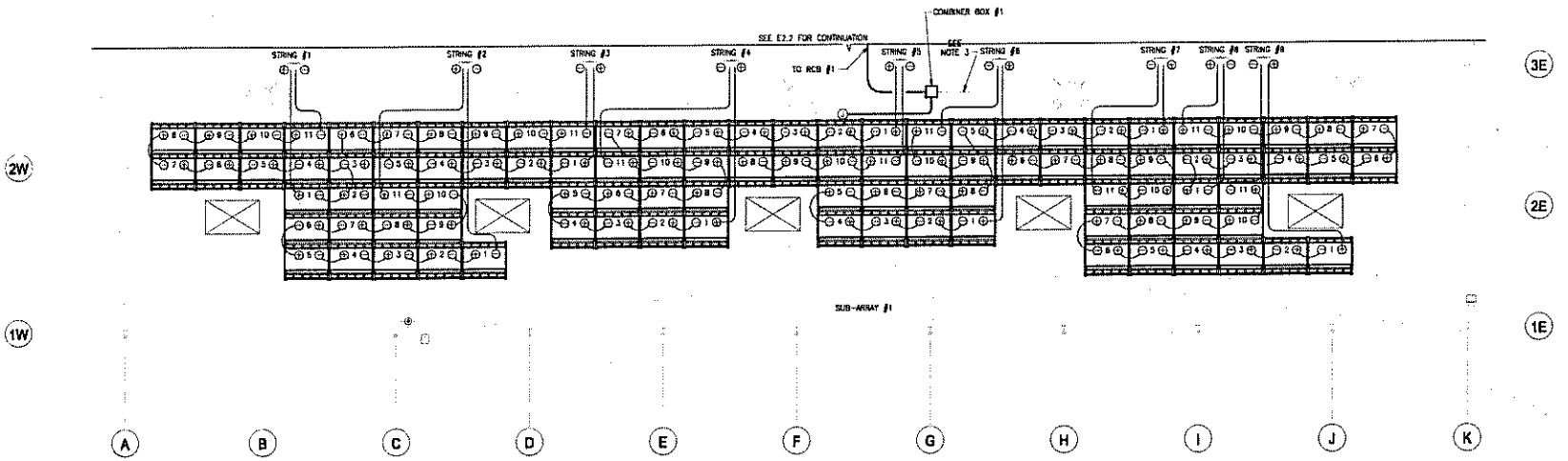
ELECTRICAL ROOF PLAN

E1.1

1. STRING WIRING SHOWN EXAGGERATED FOR CLARITY.

2. ROUTE STRING WIRES EAST-WEST ALONG THE BACK OF THE NORTH ARRAY ROW USING HEYCO MAXRUNNER CABLE CLIPS AND NORTH-SOUTH USING HELLERMANN TYTON FIR TREE MOUNT CABLE TIES TO MINIMIZE NEED FOR CONDUITS TO ROUTE STRING WIRING.

3. STRINGS #1 THROUGH #8 ROUTED TO COMBINER BOX #1. FIELD DETERMINE LOCATION OF TRANSITION OF STRING WIRES FROM BACK OF SOLON SOL QUICK UNITS TO CONDUIT FOR COMBINER BOX #1 TIE-IN.



SCALE: 1/8" = 1'-0"

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0' 4' 8' 16'

SCALE: 1/8"=1'-0"

AEPC Group, LLC

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MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SDR REVIEW	3/1/13	A

SHEET INFORMATION

Date	2/14/13
Job	STPU-13006
Scale	N.T.S.
Drawn	FMC
Checked By	AK

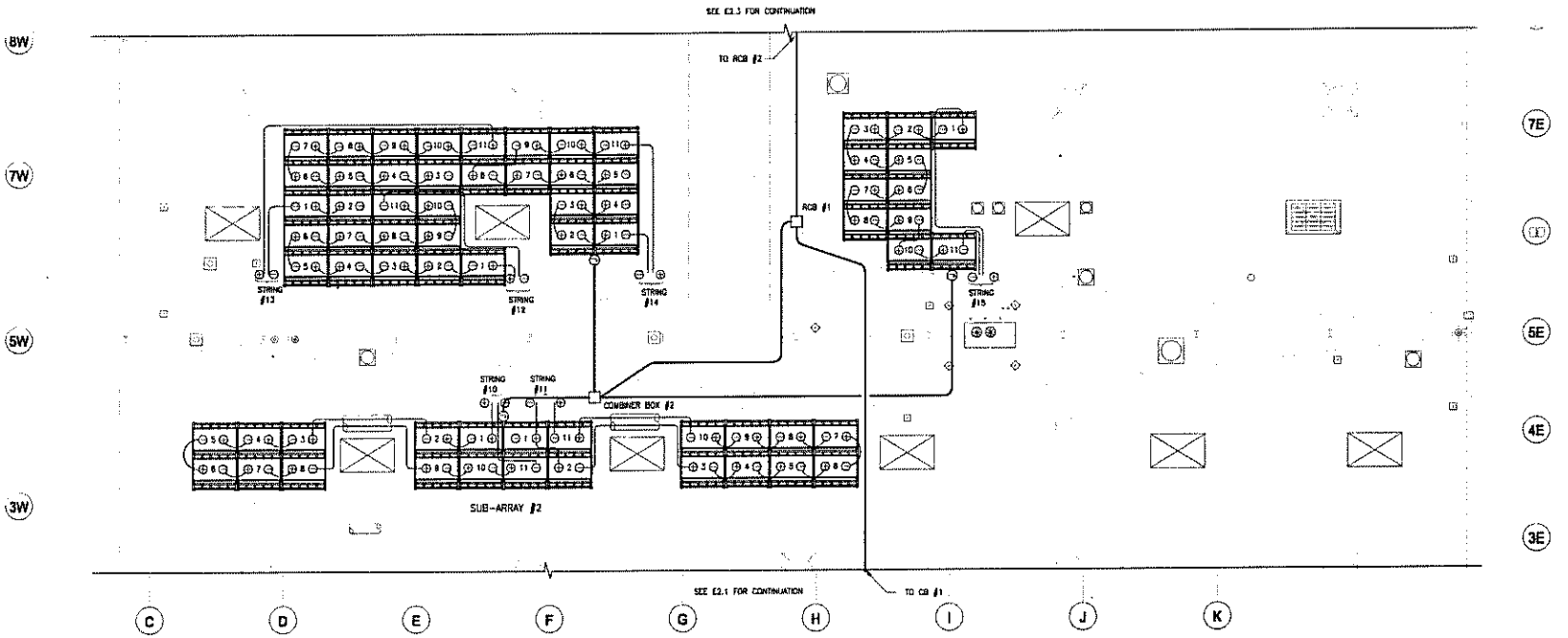
ELECTRICAL PARTIAL STRING WIRING PLAN

SHEET

E2.1

OF SHEETS

1. STRING WIRING SHOWN EXAGGERATED FOR CLARITY.
2. ROUTE STRING WIRES EAST-WEST ALONG THE NORTH ARRAY ROW USING HUBBELL WIRERUNNER CABLE CLIPS AND NORTH-SOUTH USING HELLERMANN TYTON FIR TREE MOUNT CABLE TIES TO MINIMIZE NEED FOR CONDUITS TO ROUTE STRING WIRING.
3. STRINGS #10 THROUGH #15 ROUTED TO COMBINER BOX #2. FIELD DETERMINE LOCATION OF TRANSITION OF STRING WIRES FROM BACK OF SOLON SOL QUICK LINKS TO CONDUIT FOR COMBINER BOX #2 TIE-IN.



SCALE: 1/8" = 1'-0"

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0' 4' 8' 16'

SCALE: 1/8"=1'-0"

AEPC Group LLC

TM

TRS

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SDS REVIEW	3/1/13	A

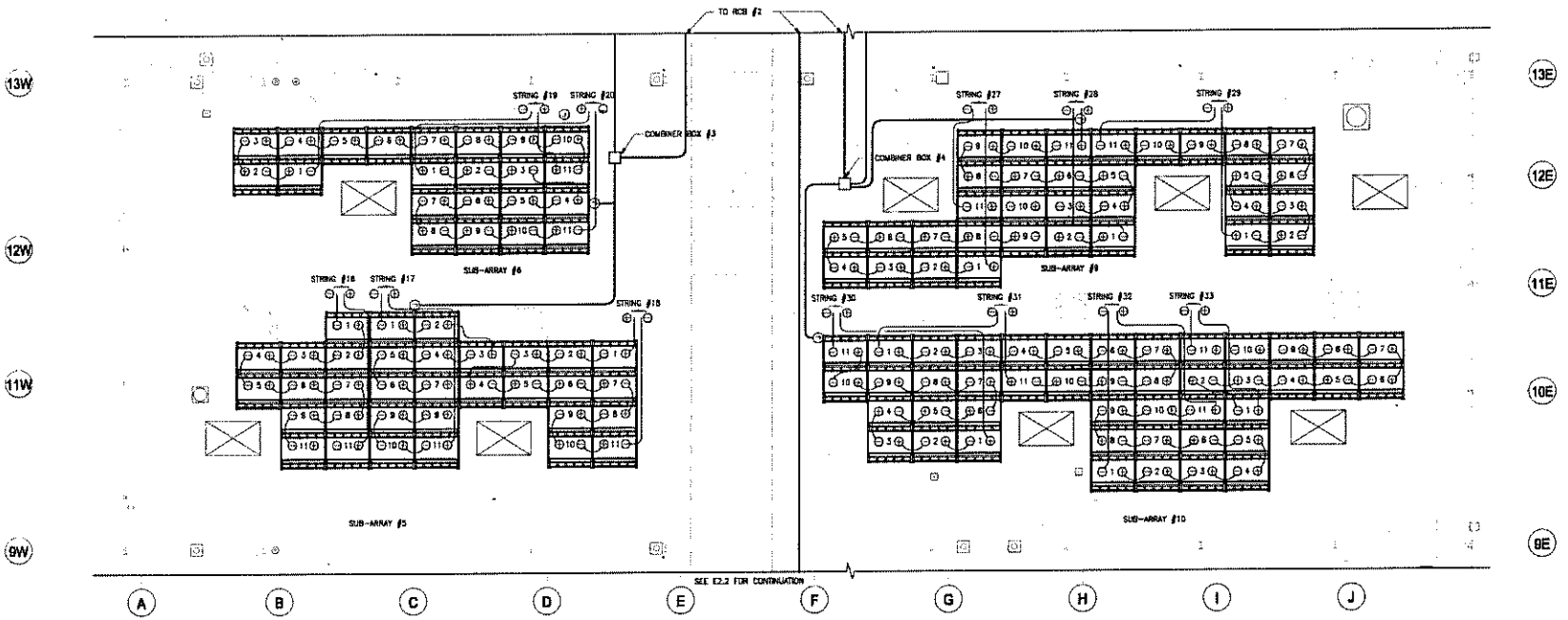
SHEET INFORMATION

Date	2/14/13
Job	SFPU-13006
Scale	N.T.S.
Drawn	FMC
Checked By	AK

ELECTRICAL PARTIAL STRING WIRING PLAN

SHEET
E2.2
OF SHEETS

1. STRING WIRING SHOWN EXAGGERATED FOR CLARITY.
2. ROUTE STRING WIRES EAST-WEST ALONG THE BACK OF THE NORTH ARRAY ROW USING HILTI MAXRUNNER CABLE CLIPS AND NORTH-SOUTH USING HELLERMANN TYTON FIR TREE MOUNT CABLE TIES TO MINIMIZE NEED FOR CONDUITS TO ROUTE STRING WIRING.
3. STRINGS #16 THROUGH #20 ROUTED TO COMBINER BOX #3, STRINGS #27 THROUGH #33 ROUTED TO COMBINER BOX #4. FIELD DETERMINE LOCATION OF TRANSITION OF STRING WIRES FROM BACK OF SOLON 501 QUICK UNITS TO CONDUIT FOR COMBINER BOX TIE-IN.



SCALE: 1/8" = 1'-0"

N

0' 4' 8' 16'

SCALE: 1/8"=1'-0"

AEPC Group LLC

TM

TRS

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

BDS REVIEW	3/1/13	A

SHEET INFORMATION

Date	2/14/13
Job	SFPU-13006
Scale	N.T.S.
Drawn	FMC
Checked By	AK

ELECTRICAL PARTIAL STRING WIRING PLAN

SHEET

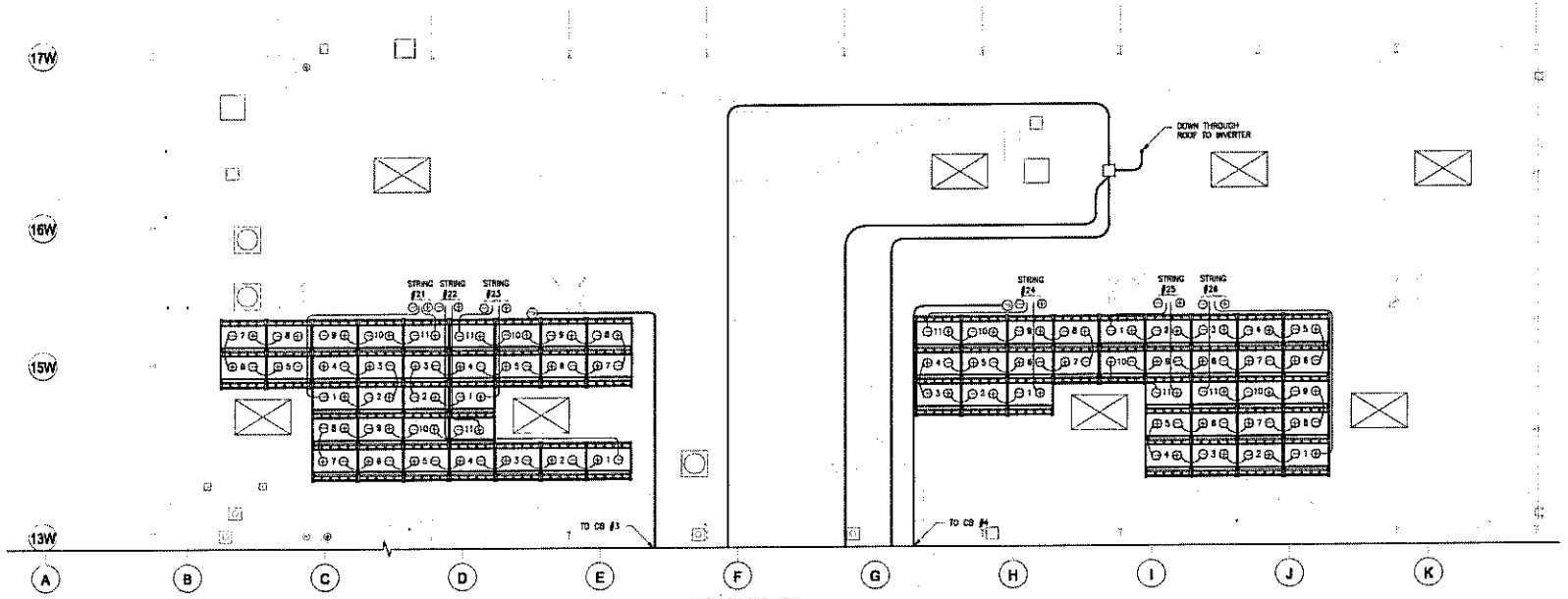
E2.3

OF SHEETS

1. STRING WIRING SHOWN EXAGGERATED FOR CLARITY.

2. ROUTE STRING WIRES EAST-WEST ALONG THE BACK OF THE NORTH ARRAY ROW USING HELTO MAXRUNNER CABLE CLIPS AND NORTH-SOUTH USING HELLERMANN TYTON FIR TREE MOUNT CABLE TIES TO MINIMIZE NEED FOR CONDUITS TO ROUTE STRING WIRING.

3. STRINGS #21 THROUGH #23 ROUTED TO COMBINER BOX #3. STRINGS #24 THROUGH #26 ROUTED TO COMBINER BOX #4. FIELD DETERMINE LOCATION OF TRANSITION OF STRING WIRES FROM BACK OF SOLON 501 QUICK UNITS TO CONDUIT FOR COMBINER BOX TIE-IN.



SCALE: 1/8" = 1'-0"

N

0' 4' 8' 16'

SCALE: 1/8"=1'-0"

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TRS

MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SDE REVIEW	3/1/13	A

SHEET INFORMATION

Date: 2/14/13
Job: SFPU-13008
Scale: N.T.S.
Drawn: PMC
Checked By: AK

TITLE
ELECTRICAL
PARTIAL
STRING
WIRING PLAN

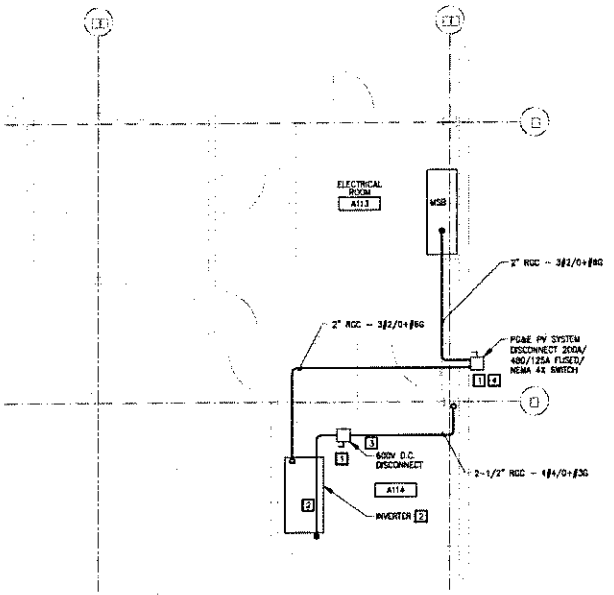
SHEET
E2.4
OF SHEETS

1 MOUNT DISCONNECT SWITCHES 5'-0" AFF.

2 THE DIMENSIONS ARE BASED ON AE POWERED AE100TX – 100KW/480V INVERTER
WIDTH – 59-7/8"
DEPTH – 31-7/8"
HEIGHT – 104-1/4"
WEIGHT – 3000 LBS

3 600V, 400A DC DISCONNECT SQUARE D CAT. # HU265AWK

4 480V, 200A AC DISCONNECT SQUARE D CAT. #H364DS



SCALE: 1/4" = 1'-0"

N

0' 1' 2' 4' 8'
SCALE: 1/4"=1'-0"

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MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

SDS REVIEW	3/1/13	A

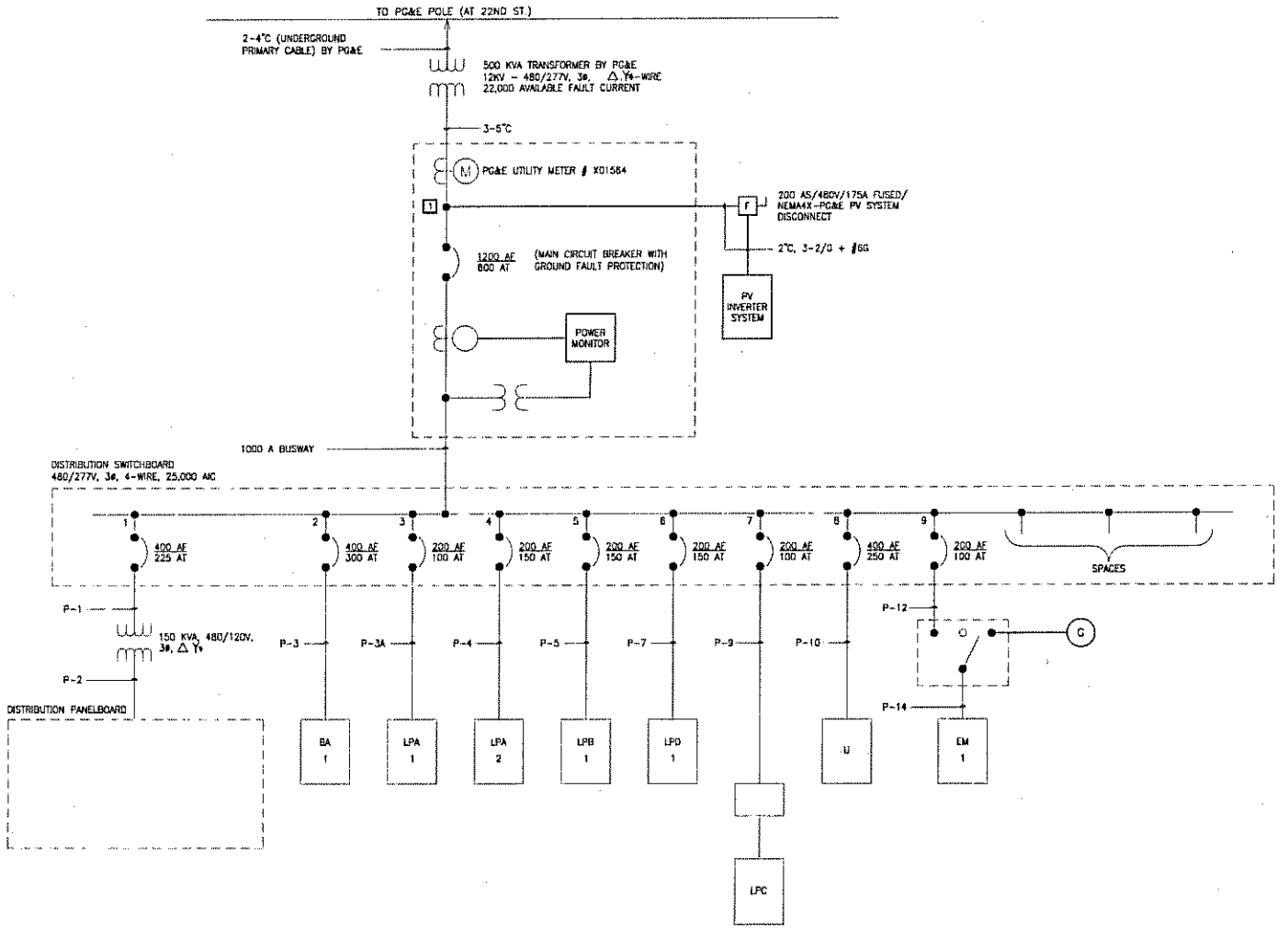
SHEET INFORMATION

Date	2/14/13
Job	SFPU-13006
Scale	N.T.S.
Drawn	FMC
Checked By	AK

TITLE
ELECTRICAL ROOM PLAN

SHEET
E2.5
OF SHEETS

[1] TIE IN THE PV FEEDER BETWEEN LINE SIDE OF MAIN BREAKER AND PG&E METER.



SCALE: NTS

AEPC Group LLC

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MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

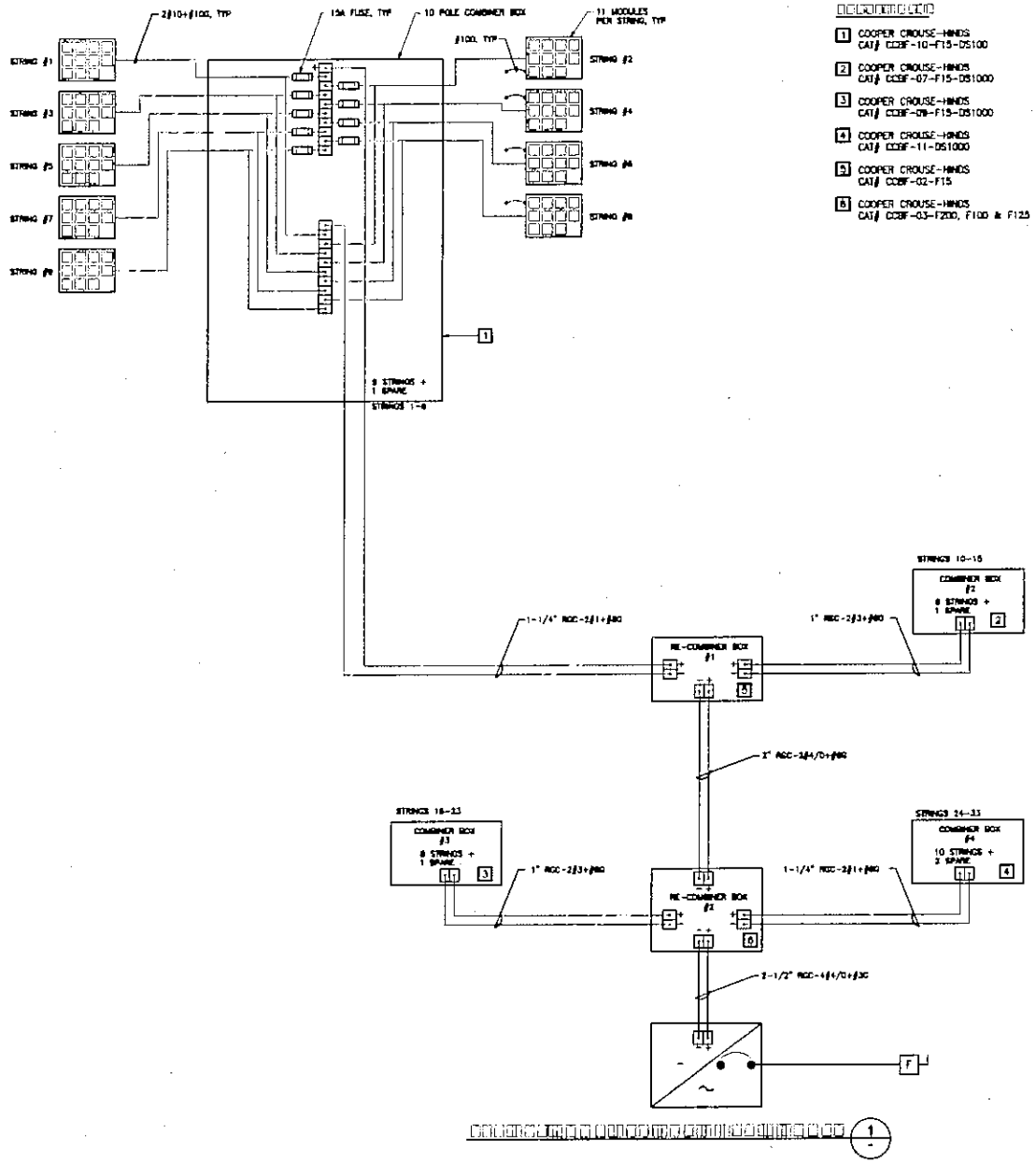
REVISIONS		
SDS REVIEW	3/1/13	A

SHEET INFORMATION

Date	2/14/13
Job	STPU-13006
Scale	N.T.S.
Drawn	FMC
Checked By	AK

ELECTRICAL SINGLE LINE DIAGRAM

SHEET
E5.1
OF SHEETS



1 COOPER CROUSE-HINDS CAT# CCBF-10-F15-DS100

2 COOPER CROUSE-HINDS CAT# CCBF-07-F15-DS1000

3 COOPER CROUSE-HINDS CAT# CCBF-09-F15-DS1000

4 COOPER CROUSE-HINDS CAT# CCBF-11-DS1000

5 COOPER CROUSE-HINDS CAT# CCBF-02-F15

6 COOPER CROUSE-HINDS CAT# CCBF-03-F200, F100 & F125

STRING CALCULATIONS/ADVANCED

PV MODULE	SOLON BLUE-07-H
NUMBER OF MODULES PER STRING	11
VOLTAGE PER MODULE (VMPP) (1)	36.10V
OPEN CIRCUIT VOLTAGE (VOC) (1)	44.3V
VOLTAGE CORRECTION FACTOR (USE VOC TABLE ABOVE OR NEC TEMP CORRECTION)	1.17/-0.190V/DEG C
SHORT CIRCUIT CURRENT PER MODULE (ISC) (1)	8.98A
MAX CURRENT CURRENT PER STRING (NEC 690.8(A)(1))	10.5A
MINIMUM CONDUCTOR AMPACITY (NEC 690.8(A))	13.13A
FUSE SIZE	15A
CONDUCTOR CHOSEN	#10 AWG-2 OR LESS-2
CONDUCTOR TEMPERATURE	90F
CONDUCTOR AMPACITY	40A
AMBIENT TEMP DERATING (NEC TABLE 310.15(B)(2)(a)) (2)	0.91
CONDUCTOR DERATED AMPACITY	36.4A
LONGEST STRING DISTANCE	300 FT
MAXIMUM DAY VOLTAGE ((VOC) MODULES x VMPP)	367.1V
CONSIDERED DAY VOLTAGE ((VOC) MODULES x VOC x VF)	384.76V
WORST CASE VOLTAGE DROP	1.14%

(1) BASED ON PANEL MANUFACTURER PUBLISHED DATA
(2) BASED UPON RECORD HIGH AMBIENT TEMP (F)
(3) BASED UPON RECORD LOW AMBIENT TEMP (F)
NOTE: WEATHER DATA OBTAINED FROM WEATHER.COM

COMBINER CALCULATIONS COMBINER BOX #1

PV MODULE	SOLON BLUE-07-H
NUMBER OF MODULES PER STRING	11
NUMBER OF STRINGS PER COMBINER	8
VOLTAGE PER STRING (1)	367.1V
SHORT CIRCUIT CURRENT PER STRING (ISC) (1)	8.4A
MINIMUM CONDUCTOR AMPACITY (# STRINGS x 1.56)	118A
CONDUCTOR CHOSEN	#3
CONDUCTOR TEMPERATURE	90° DEG
CONDUCTOR AMPACITY	180A
AMBIENT TEMP DERATING (NEC TABLE 310.15(B)(2)) (2)	0.91
CONDUCTOR DERATED AMPACITY	136.5A
LONGEST CONDUCTOR DISTANCE FROM COMBINER TO RECOMBINER BOX #1	100 FT
WORST CASE VOLTAGE DROP (3)	1.4%

(1) REFER TO STRING CALCULATIONS FOR MORE INFORMATION
(2) BASED UPON RECORD HIGH AMBIENT TEMP (F)

COMBINER CALCULATIONS COMBINER BOX #2

PV MODULE	SOLON BLUE-07-H
NUMBER OF MODULES PER STRING	11
NUMBER OF STRINGS PER COMBINER	8
VOLTAGE PER STRING (1)	367.1V
SHORT CIRCUIT CURRENT PER STRING (ISC) (1)	8.4A
MINIMUM CONDUCTOR AMPACITY (# STRINGS x 1.56)	78.4A
CONDUCTOR CHOSEN	#3
CONDUCTOR TEMPERATURE	90F
CONDUCTOR AMPACITY	118A
AMBIENT TEMP DERATING (NEC TABLE 310.15(B)(2)) (2)	0.91
CONDUCTOR DERATED AMPACITY	107A
LONGEST CONDUCTOR DISTANCE FROM COMBINER	100 FT
WORST CASE VOLTAGE DROP (3)	0.85%

(1) REFER TO STRING CALCULATIONS FOR MORE INFORMATION
(2) BASED UPON RECORD HIGH AMBIENT TEMP (F)

COMBINER CALCULATIONS COMBINER BOX #3

PV MODULE	SOLON BLUE-07-H
NUMBER OF MODULES PER STRING	11
NUMBER OF STRINGS PER COMBINER	8
VOLTAGE PER STRING (1)	367.1V
SHORT CIRCUIT CURRENT PER STRING (ISC) (1)	8.4A
MINIMUM CONDUCTOR AMPACITY (# STRINGS x 1.56)	125A
CONDUCTOR CHOSEN	#3
CONDUCTOR TEMPERATURE	90F
CONDUCTOR AMPACITY	180A
AMBIENT TEMP DERATING (NEC TABLE 310.15(B)(2)) (2)	0.91
CONDUCTOR DERATED AMPACITY	118A
LONGEST CONDUCTOR DISTANCE FROM COMBINER	100 FT
WORST CASE VOLTAGE DROP (3)	1.54%

(1) REFER TO STRING CALCULATIONS FOR MORE INFORMATION
(2) BASED UPON RECORD HIGH AMBIENT TEMP (F)

COMBINER CALCULATIONS COMBINER BOX #4

PV MODULE	SOLON BLUE-07-H
NUMBER OF MODULES PER STRING	11
NUMBER OF STRINGS PER COMBINER	10
VOLTAGE PER STRING (1)	367.1V
SHORT CIRCUIT CURRENT PER STRING (ISC) (1)	8.4A
MINIMUM CONDUCTOR AMPACITY (# STRINGS x 1.56)	131A
CONDUCTOR CHOSEN	#1
CONDUCTOR TEMPERATURE	90F
CONDUCTOR AMPACITY	150A
AMBIENT TEMP DERATING (NEC TABLE 310.15(B)(2)) (2)	0.91
CONDUCTOR DERATED AMPACITY	136.5A
LONGEST CONDUCTOR DISTANCE FROM COMBINER	100 FT
WORST CASE VOLTAGE DROP (3)	1.14%

(1) REFER TO STRING CALCULATIONS FOR MORE INFORMATION
(2) BASED UPON RECORD HIGH AMBIENT TEMP (F)

APC Group LLC
TM
TRS

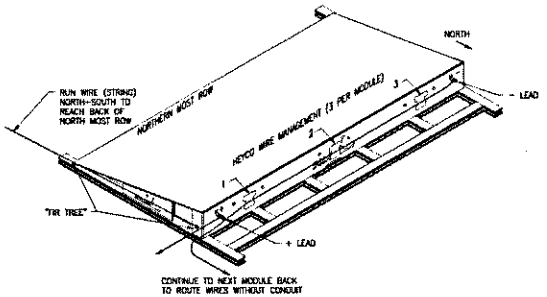
MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

ISSUE RECORD	2/1/13	A

SHEET INFORMATION
Date: 2/25/13
Job: SFPU-13008
Scale: N.T.S.
Drawn: SCS
Checked by: AK

ELECTRICAL COMBINER CALCULATIONS & RISER DIAGRAM

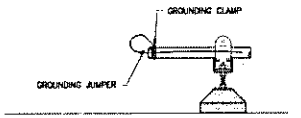
E6.1


NORTH
RUN WIRE (STRING) NORTH-SOUTH TO REACH BACK OF NORTH MOST ROW
NORTHERN MOST ROW
ADTCO WIRE MANAGEMENT (3 PER MODULE)
- LEAD
"FIR TREE"
+ LEAD
CONTINUE TO NEXT MODULE BACK TO ROUTE WIRES WITHOUT CONDUIT

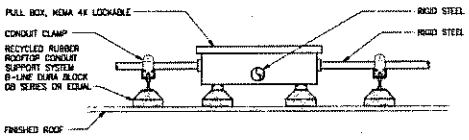
SCALE: NONE 5

	PV UNIT MODEL #	Wattage (STC)	PV Unit Width (inches)	PV Unit Length (inches)	PV Unit Thickness (inches)	PV Unit Area (sqft)	PV watts/sq .ft	PV Unit Weight (lbs)	PV Unit Weight - lbs/sf	Number of Units per String	Number of Strings	Total Number of Units
1	SOLON SOLQUICK BLUE XT-H	280	53.8	78.9	8	30.8	9.5	80	2.71	11	33	363

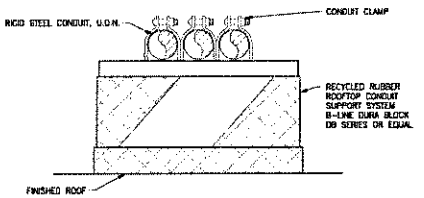
SCALE: NONE 6



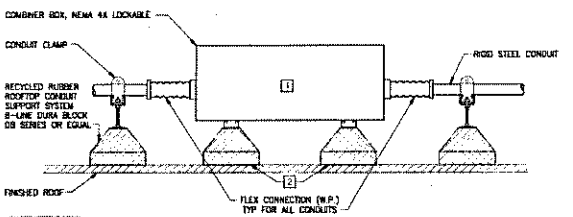
SCALE: NONE 1


PULL BOX, NEMA 4X LOCKABLE
CONDUIT CLAMP
RECYCLED RUBBER ROOFTOP CONDUIT SUPPORT SYSTEM B-LINE DURA BLOCK DB SERIES OR EQUAL
FINISHED ROOF
RIGID STEEL CONDUIT
RIGID STEEL CONDUIT

SCALE: NONE 2


RIGID STEEL CONDUIT, U.O.N.
CONDUIT CLAMP
RECYCLED RUBBER ROOFTOP CONDUIT SUPPORT SYSTEM B-LINE DURA BLOCK DB SERIES OR EQUAL
FINISHED ROOF

SCALE: NONE 3


COMBINER BOX, NEMA 4X LOCKABLE
CONDUIT CLAMP
RECYCLED RUBBER ROOFTOP CONDUIT SUPPORT SYSTEM B-LINE DURA BLOCK DB SERIES OR EQUAL
FINISHED ROOF
RIGID STEEL CONDUIT
1
2
FLEX CONNECTION (W.P.) TYP FOR ALL CONDUITS

1 ADD ROOF PAD IF REQUIRED BELOW DURA BLOCK SUPPORTS TO ACCOMMODATE FIELD CONDITIONS.

SCALE: NONE 4

AEPC Group, LLC

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MUNI WAYS & STRUCTURES FACILITY
PHOTOVOLTAIC (PV) PROJECT
700 Pennsylvania Avenue, San Francisco, CA

BOS REVIEW	2/1/13	A

SHEET INFORMATION

Date	2/22/13
Job	SFPUC 13006
Scale	AS NOTED
Drawn	SDS
Checked By	AK

DETAILS

SHEET

E7.1

SOLON SOLquick™

Photovoltaic System for Flat Rooftops.

SOLON
Innovation

- Versatile design for nearly all types of flat roofs
- Fully-integrated unit—No tools needed
- Fast plug-and-play design
- Suitable for lightweight roofs from 2.8 lbs/ ft^2 load-carrying capacity
- Low-cost installation
- No grounding required

SOLON

Innovative.
Fast. Simple.

The SOLON SOLquick™ system's innovative design for flat roofs integrates the solar module and mount into one unit for a fast, easy and tool-free installation. Frameless modules are installed on the unit at an inclination of 10 degrees to ensure maximum area and energy optimization. Weighing less than 2.8 lbs/ft², the unique flat-roof system is suitable for all non-metal, commercial rooftops.

ENGINEERED WITH FIBREX®

Fibrex® Material from Andersen Corporation:
Ideally suited for commercial, industrial and utility-scale systems, SOLON SOLquick's lightweight frame is constructed with Fibrex materials from Andersen Corporation. Used in outdoor construction since 1993, the patented Fibrex composite material is made out of reclaimed wood fiber from Andersen manufacturing operations and a special thermoplastic polymer, some of which is also partially reclaimed. Fibrex material is non-conductive as well as moisture and heat resistant. The outdoor durability and reliability of Fibrex material has been tested for more than 18 years by the worldwide leader of high quality windows and doors, Andersen®.

"SOLquick" is a trademark of SOLON Corporation. "Andersen" and "Fibrex" are registered trademarks of Andersen Corporation.

Higher Performance.

- Optimal energy output due to 10° inclination with no shading
- Maximum output per square foot of roof area used

Simple and Fast Installation.

- Modular unit—ships as fully-integrated laminate and mount
- No tools or assembly required
- Streamlined, labor saving design
- No staging required
- Flexible installation solutions for various roof surfaces—self-ballasted, ballasted and roof penetrating

Reliable Statics.

- System weight of only 2.8 psf
- Meets the requirements of UL
- Wind tunnel tested

Roof Protection.

- Non-penetrating installation design [1)]
- Lightweight materials
- Can be affixed to roof with standard penetration methods.
- Low edge loading

Stability in all Aspects.

- Innovative materials for long-term durability
- Quick-click U-bolt interconnects
- No grounding required

For Sustainable Satisfaction: Up to 25 Years Guarantee.

In addition to our comprehensive warranties and services, we provide up to 25 years guarantee. SOLON SOLquick is not only distinguished by its reliability, but it is also easy on your roof.

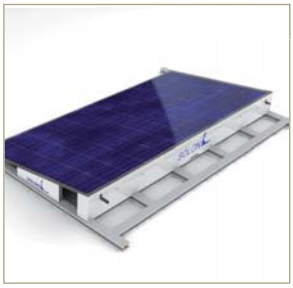
SOLON Advantages:

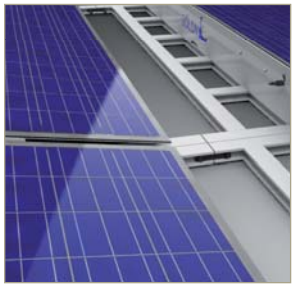
- **10-year product guarantee [1)]**
- **25-year performance guarantee [1)]**
- **Positive sorting of power classes (0 to + 4.99 Wp)**

[1)] According to SOLON Product and Performance Guarantee.

[1)] Depends on snow and wind load, seismic terrain category and height of building.

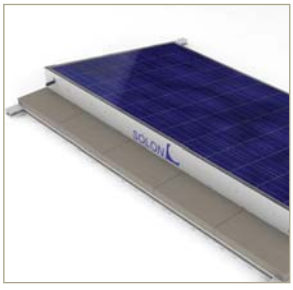
Tool-Free Installation.





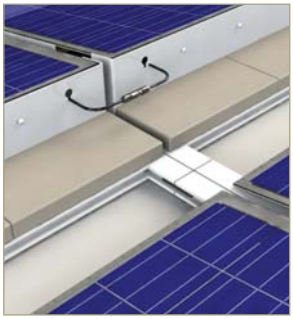
1. Place.

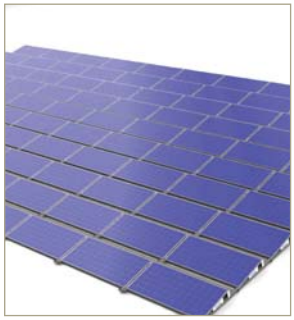
- Mark the corner of the first SOLON SOLquick row
- Remove product from wrapped pallet
- Place SOLON SOLquick unit on roof in the designated location



2. Secure.

- Link the units together with the quick-click U-bolt
- Three fast mounting methods for customer needs
- Self-ballasting, ballasting or roof penetrating—depending on the roof structure





3. Connect.

- Cable channels already integrated (UV protection)
- Electrically interconnect modules
- No grounding required

SOLON SOLquick™ Photovoltaic System

Electrical specifications – typical (STC)

STC (Standard Test Conditions): 1,000 W/m², 77 ± 3.6°F (25 ± 2°C), AM 1.5			
Capacity rating	P_{max}	285 Wp	280 Wp
Module efficiency		14.39%	14.14%
Rated voltage	V_{mpp}	36.25 V	35.95 V
Rated current	I_{mpp}	7.86 A	7.78 A
Open circuit voltage	V_{OC}	44.30 V	44.08 V
Short circuit current	I_{SC}	8.27 A	8.20 A
Series fuse rating	I_R	15 A	15 A
Maximum system voltage	V_{DC}	600 V	600 V

Positive bin sorting of Pmax of 0 to 4.9 Watts

Reduction of module efficiency from 1,000 W/m² to 200 W/m²: <5%

Electrical specifications – typical (NOCT)

NOCT (Normal Operating Cell Temperature): 800 W/m², NOCT, AM 1.5			
Capacity rating	P_{max}	207 Wp	204 Wp
Rated voltage	V_{mpp}	32.99 V	32.72 V
Rated current	I_{mpp}	6.29 A	6.23 A
Open circuit voltage	V_{OC}	40.45 V	40.25 V
Short circuit current	I_{SC}	6.71 A	6.66 A

Temperature coefficients (Tc)

Tc of open circuit voltage	−0.35%/K
Tc of short circuit current	0.07%/K
Tc of power	−0.45%/K
NOCT	114.8°F ± 3.6°F (46°C ± 2°C)

Measuring tolerance for all final data: ±10% (except P_{max} (STC) and NOCT)

Mechanical specification

Dimensions (H x W x D)	78.9 x 53.8 x 8.0 in.
Weight	Lightweight system- 80 lbs. just 2.8 psf
Inclination	10° nominal
Junction box	1 Tyco junction box with 3 bypass diodes
Cable	PV wire, length 83.1in. (2,110 mm), 12 AWG (4 mm²), prefabricated with Tyco Solarlok connector
Front glass	Transparent tempered safety glass, 0.16 in. (4 mm)
Solar cells	72 cells, polycrystalline, 6.14 x 6.14 in. (156 x 156 mm)
Fire class	C
Frame	Frameless

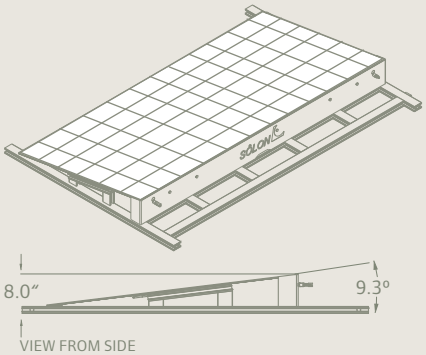
Permissible operating conditions

Temperature range	−40°F to +185°F (−40°C to +85°C)
Maximum surface load capacity	ETL tested for compressive loads up to 4,300 Pa including snow loads
Resistance against hail	Maximum diameter of 1 in. (25 mm) with impact speed of 51.5 mph (23 m/s)
Wind load	Wind load 1,500 Pa; Wind tunnel tested
Snow load	2,400 Pa

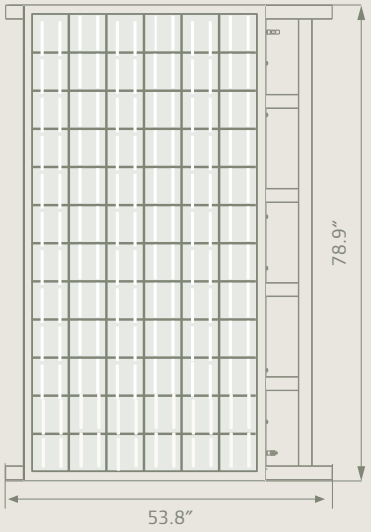
Guarantees and certifications

Product warranty	10 years [1]
Performance guarantee	Guaranteed output of 95% for 5 years, 90% for 10 years, 87% for 15 years, 83% for 20 years and 80% for 25 years [1]
Approvals and certificates	ETL listed and UL 1703 certified

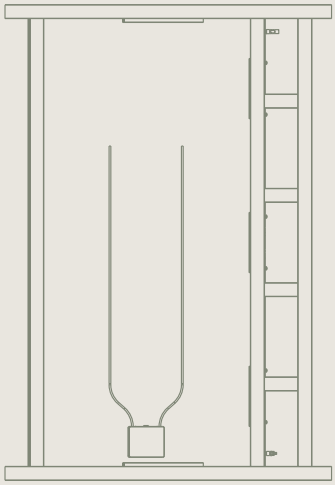
Drawing



VIEW FROM SIDE



VIEW FROM ABOVE



VIEW FROM BELOW

Subject to modifications. Electrical data without guarantee. [1] According to SOLON Product- and Performance Guarantee

SOLON Corporation
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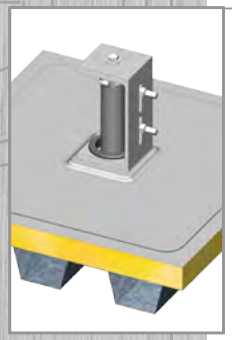
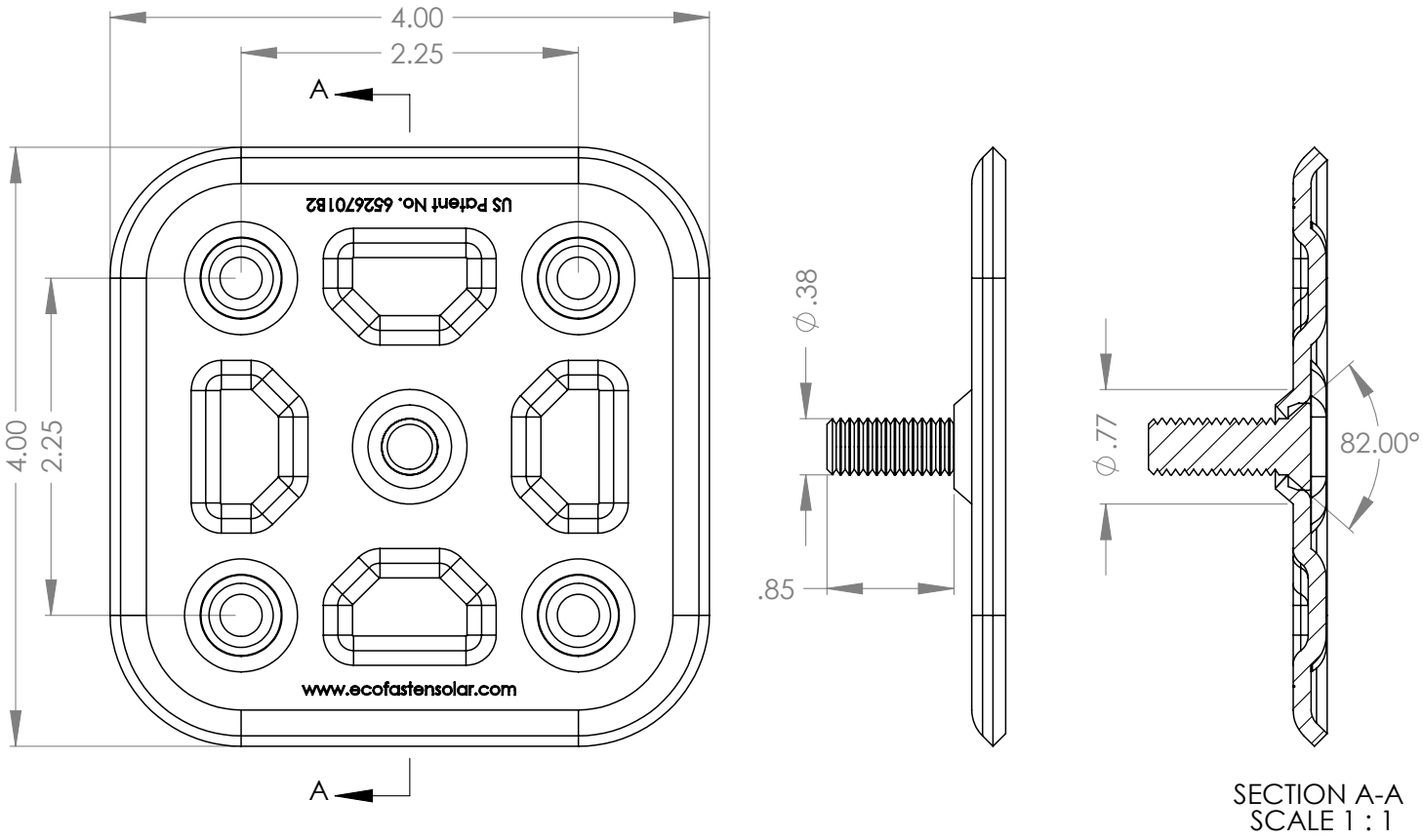
SOLON



EcoFasten Solar



SECTION A-A
SCALE 1 : 1

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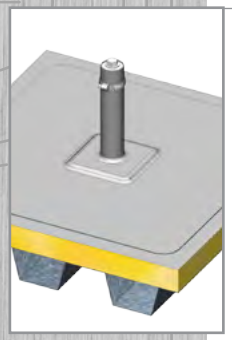

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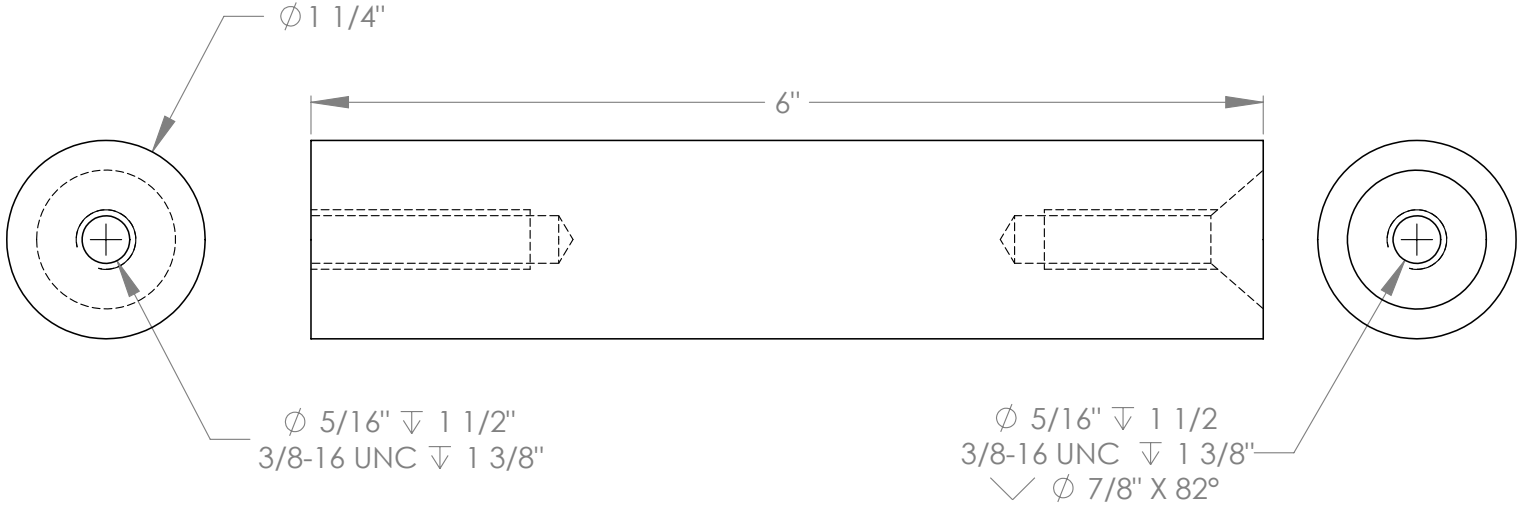

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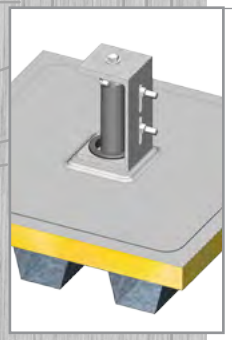
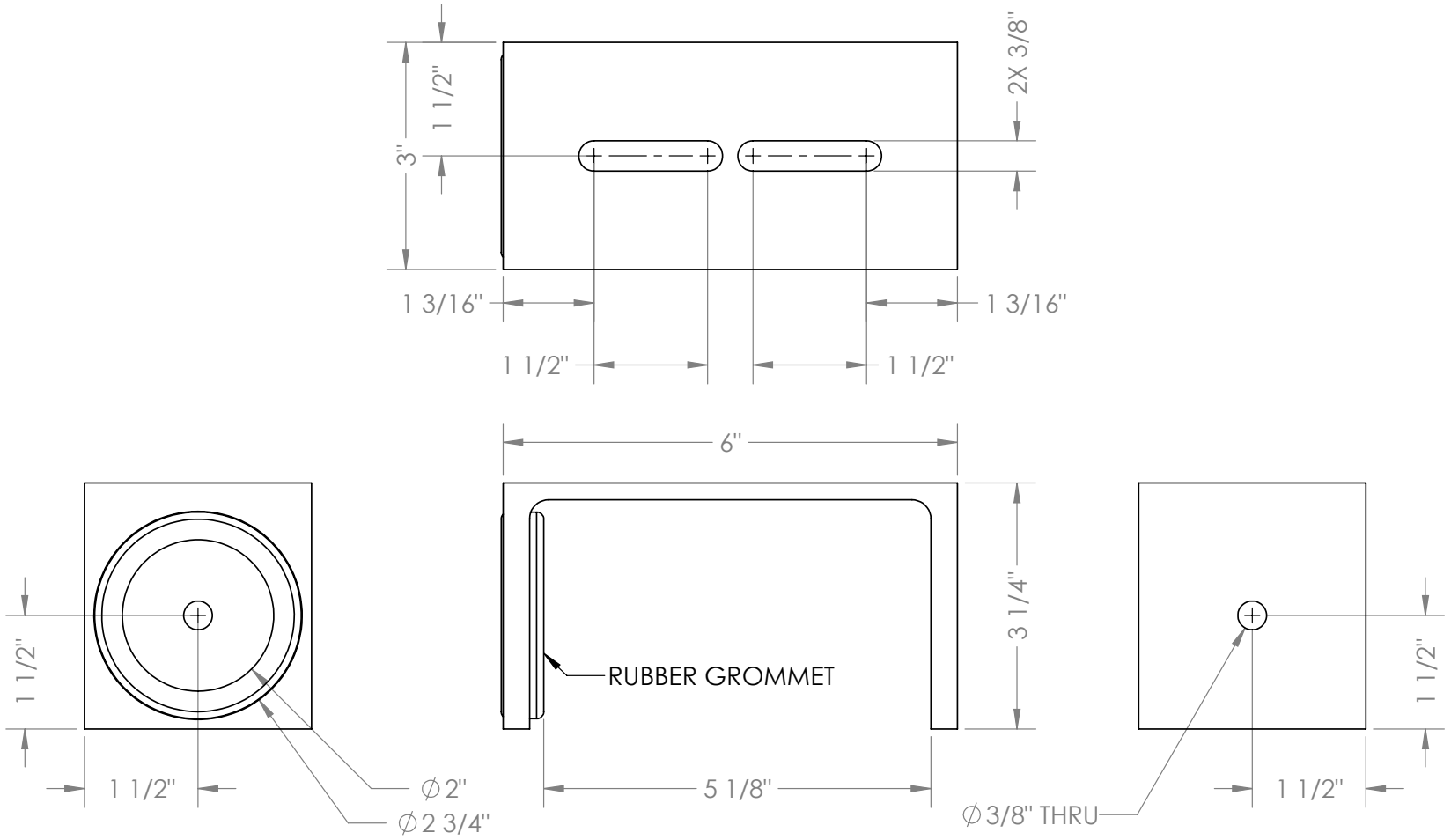


EcoFasten Solar



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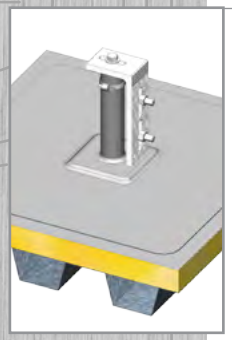

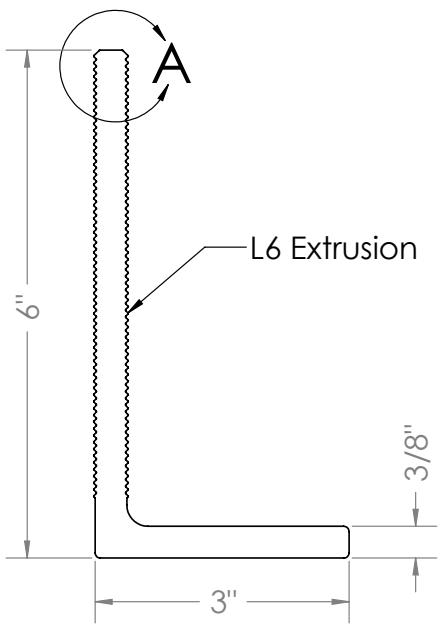

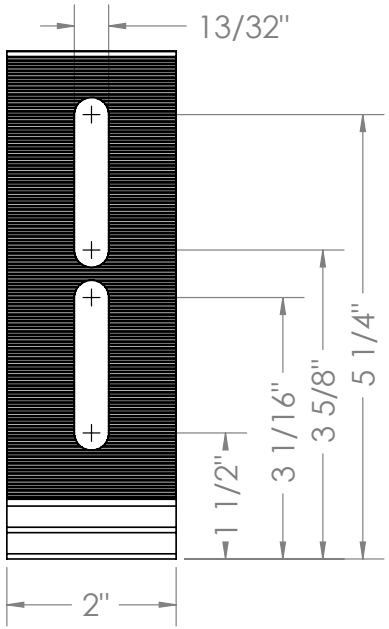

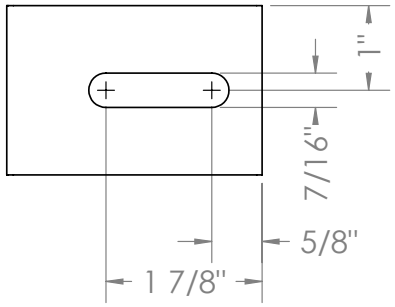

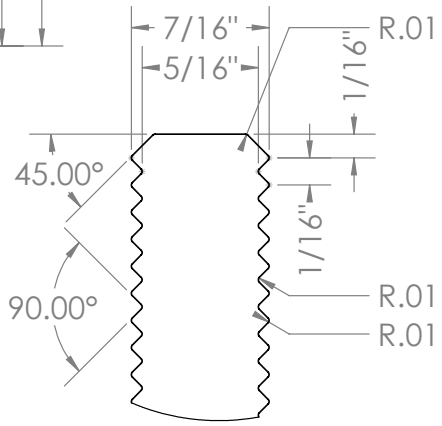

DETAIL A
SCALE 2 : 1

EcoFasten Solar

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CROUSE-HINDS COMMERCIAL PRODUCTS

Solar Combiner Solutions

Providing the most complete offering of combiners, smart combiners, recombiners, disconnects and pass through boxes for your grid-tied solar applications.

COOPER Crouse-Hinds

Third Party Certified to UL1741!

Leading the way in Solar Technology

Cooper Crouse-Hinds® solar combiner boxes and recombiner boxes for the solar market integrate a comprehensive line of electrical products with expert support, industry insights, and local availability to improve safety and productivity in the most demanding industrial, commercial and residential environments worldwide.

Solar Background Information

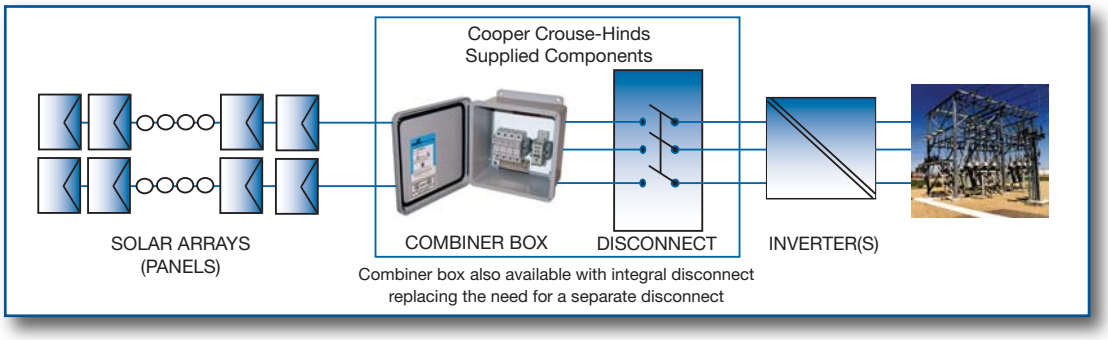
A solar array may be one panel or many in series, and may range from a single 12 volt panel to high voltage multi-panel arrays for grid-tie systems. Grid-tied systems can go as high as 1000 VDC, while battery systems are typically 12, 24, or 48 V.

Higher voltage systems (over 48 V) have different NEC code requirements than those for low voltage battery systems, and the two types are NOT interchangeable.

Cooper Crouse-Hinds Solar Combiners are designed for higher voltage circuits used in grid-tied applications. All meet NEC requirements, are made in accordance with UL requirements and are protected by Cooper Bussmann® families of fast-acting fuses specifically designed for the protection and isolation of photovoltaic strings.

Typical Solar Grid System Diagram

(CCBF04 setup shown)



Cooper Crouse-Hinds Solar Protection for Fiberglass Enclosures

The Cooper Crouse-Hinds solar protection formula provides the enclosure strength and durability to provide long, dependable service even in the most demanding environmental conditions. Cooper Crouse-Hinds fiberglass enclosures retain gloss and color when exposed to harsh UV light, offer superior resistance to chemicals and are fire retardant.

A special UV absorber is added into this solar protection formula and works to absorb UV energy and release it without damaging the fiberglass enclosure thus providing increased protection of the polyester material and increased resistance to the damaging effects of UV radiation. For additional information on Cooper Crouse-Hinds Solar Protection, choose Fiberglass Enclosures from: http://www.crouse-hinds.com/contractorcorner

How to size a Solar Combiner*:

Current Inputs: Cooper Crouse-Hinds provides a "Max Short Circuit Current Rating per string" (Isc) for use as a direct comparison between the published Isc of the PV module. De-rating requirements per article 690 of the NEC are applied and should be used to make a direct comparison with the PV module Isc ratings (i.e. CCBF18 has an Isc rating of 8.8A. PV modules with Isc ratings at or below 8.8A would be acceptable).

Consult electrical ratings table found in the technical section of this brochure.

Voltage Inputs: (600VDC/1000VDC systems) – Cooper Crouse-Hinds provides the total system voltage ratings to be used in comparison with the sum of the max number of modules in series per string.

Consult NEC, ANSI and local codes when designing a system.

Integral Disconnect Switch Sizing:

To determine the rating of the integral disconnect, simply multiply the number of input circuits by the ampacity rating of each fuse in the circuit. Round to the next (higher) trip rating. In NO case can the max current exceed the trip rating of the disconnect switch. Example: a 12 string combiner box with each input circuit with a fuse rated at 15 Amps is 12 x 15 = 180. Minimum rating for the switch would be 200 Amps.

*The information above is provided for reference and information only. All statements, technical information and recommendations contained herein are based on information and test we believe to be reliable. The accuracy or completeness thereof are not guaranteed. In accordance with Cooper Crouse-Hinds' Terms and Conditions of Sale, and since conditions of use are outside our control, the purchaser should determine the suitability of the product for his/her intended use and assumes all risk and liability whatsoever in connection therewith.

Solar Combiners

Cooper Crouse-Hinds Solar Combiners are used to group input wires/circuits from several arrays and/or solar panels. The combined circuit results in fewer output circuits and combines them into one main buss or feed going to the inverter saving labor and material costs. Available with optional integral disconnect and DC string monitoring capabilities.

Application:

Cooper Crouse-Hinds Solar Combiner Solutions are designed and built to minimize system costs by providing maximum flexibility. Solar Combiner Solutions offer a range of 1 to 48* input circuits, with a durable non-metallic (NEMA 4X) enclosure, engineered and manufactured to perform in the harshest environmental conditions. UL 1741 Listed* as standard, providing peace of mind and plenty of wiring room for ease of installation.

Features:

- Rated for 600 VDC or 1000VDC - continuous duty
- Touch-Safe fuse holders and power distribution blocks for safe operation
- 90ºC output terminals
- NEMA 4X Fiberglass enclosures with captive stainless steel screws and formed-in-place polyurethane seamless gasket provided as standard
- Also available in NEMA 3R painted steel, NEMA 4 powder coated steel or NEMA 4X stainless steel
- Configured for positive and negative grounded arrays

Standard Materials and Finishes:

Fiberglass Enclosure:

- Hot compression molded fiberglass-reinforced thermoset polyester
- Non-conductive, impact resistant, UV resistant, flame retardant
- Captive cover screws can't be dropped or lost
- Poured polyurethane seamless gasket provides watertight, dust-tight environmental seal
- Stainless steel used on all external hardware

Certification and Compliances:

- cULus 1741 Listed* - UL File No. E330318
- cETLus 1741 Listed*
- NEMA 4X (fiberglass and stainless steel)
- NEMA 4 (powder coated steel)
- NEMA 3R (painted steel)
- Made in America

Options:

- Fuses (shipped uninstalled)
- Surge protection
- NEMA 3R Painted Steel
- NEMA 4 Powder Coated Steel
- NEMA 4X Stainless Steel
- Solar Cable Whips (preassembled and installed)
- Busbar Design
- Smart combiners available (DC string monitoring)
- Factory drilled entrance holes
- Factory installed connectors/cable glands
- Dual output lugs
- Custom options available - Consult factory

Catalog Numbering System

Use the table below to build a catalog number for a combiner configuration that matches your specific project requirement

BASE SOLAR COMBINER		WITH OPTIONAL FACTORY SUPPLIED FUSES	W/OPTIONAL SURGE PROTECTION	DC MONITORING	VOLTAGE
CCBF	12	F15	SP	DCM	
Enclosure Type	**Number of Input Circuits**	**Fuse Amperage**	**Surge Protection**	**DC Monitoring**	**Voltage**
CCBF (Fiberglass N4X) **CCBS** (Painted Steel N3R) **CCBSS** (Stainless Steel N4X) **CCB4S** (Powder Coated Steel N4)	**01** (1 input circuit) **02** (2 input circuit) **03** (3 input circuit) **04** (4 input circuit) **05** (5 input circuit) **06** (6 input circuit) (Offered up to 48 circuits*)	**F08** (8A fuse) **F10** (10A fuse) **F12** (12A fuse) **F15** (15A fuse) (Offered up to 30A) **BLANK** (Fuses not provided by factory) • Cooper Bussmann fuses recommended - DCM fuses for 600VDC combiner boxes - PV fuses for 1000VDC combiner boxes	**SP** (Surge Protection) • 30kA/600VDC Interrupting Rating • IP20 finger-safe construction • Small size takes up minimal space in enclosure (Only 2 inches wide) **BLANK** (No surge protection)	**DCM** Pre-installed DC current monitoring unit (qty 1 per 8 strings) **BLANK** (No DC current monitoring)	**1000V** (1000V) **BLANK** (600V)

*Combiners with 37-48 input circuits are not third party certified, but are constructed to UL 1741 standards

Solar Combiners with Integral Disconnect

Application:

Cooper Crouse-Hinds Solar Combiners with Integral Disconnects provide all the strong and durable features of our standard Solar Combiners, are available with 1-48 input circuits* and save material costs, installation time and labor by joining the combiner box and disconnect within one enclosure and eliminating the need for a disconnect switch in a separate enclosure.

Features:

- Rated for 600 VDC or 1000VDC - continuous duty
- Integral Disconnects available in 100A, 200A, 250A and 400A†
- Touch-Safe fuse holders and power distribution blocks for safe operation
- 90ºC output terminals
- NEMA 4X Fiberglass enclosures with captive stainless steel screws and formed-in-place polyurethane seamless gasket provided as standard
- Also available in NEMA 3R painted steel, NEMA 4 powder coated steel or NEMA 4X stainless steel
- Configured for positive and negative grounded arrays

Standard Materials and Finishes:

Fiberglass Enclosure:

- Hot compression molded fiberglass-reinforced thermoset polyester
- Non-conductive, impact resistant, UV resistant, flame retardant
- Captive cover screws can't be dropped or lost
- Poured polyurethane seamless gasket provides watertight, dust-tight environmental seal
- Stainless steel used on all external hardware

Integral Disconnect Switch Sizing:

To determine the rating of the integral disconnect, simply multiply the number of input circuits by the ampacity rating of each fuse in the circuit. Round to the next (higher) trip rating. In NO case can the max current exceed the trip rating of the disconnect switch. Example: a 12 string combiner box with each input circuit with a fuse rated at 15 Amps is 12 x 15 = 180. Minimum rating for the switch would be 200 Amps.

Certification and Compliances:

- cETLus 1741 Listed
- NEMA 4X (fiberglass and stainless steel)
- NEMA 4 (powder coated steel)
- NEMA 3R (painted steel)
- Made in America

Options:

- Fuses (shipped uninstalled)
- Surge protection
- NEMA 3R Painted Steel
- NEMA 4 Powder Coated Steel
- NEMA 4X Stainless Steel
- Solar Cable Whips (preassembled and installed)
- Busbar Design
- Smart combiners available (DC string monitoring)
- Factory drilled entrance holes
- Factory installed connectors/cable glands
- Dual output lugs
- Custom options available - Consult factory

Catalog Numbering System

Use the table below to build a catalog number for a combiner configuration that matches your specific project requirement

BASE SOLAR COMBINER		WITH OPTIONAL FACTORY SUPPLIED FUSES	WITH OPTIONAL INTEGRAL DISCONNECT	W/OPTIONAL SURGE PROTECTION	DC MONITORING	VOLTAGE
CCBF	12	F15	DS200	SP	DCM	
Enclosure Type	**Number of Input Circuit**	**Fuse Amperage**	**Rating for Integral Disconnect**	**Surge Protection**	**DC Monitoring**	**Voltage**
CCBF (Fiberglass N4X) **CCBS** (Painted Steel N3R) **CCBSS** (Stainless Steel N4X) **CCB4S** (Powder Coated Steel N4)	**01** (1 input circuit) **02** (2 input circuit) **03** (3 input circuit) **04** (4 input circuit) **05** (5 input circuit) **06** (6 input circuit) (Offered up to 48 circuits*)	**F08** (8A fuse) **F10** (10A fuse) **F12** (12A fuse) **F15** (15A fuse) (Offered up to 30A) **BLANK** (Fuses not provided by factory) • Cooper Bussmann fuses recommended - DCM fuses for 600VDC combiner boxes - PV fuses for 1000VDC combiner boxes	**DS** (Disconnect Switch for use with 1 - 48 input circuits) **DS100** (100A) **DS200** (200A) **DS250** (250A) **DS400** (400A) **BLANK** (No integral disconnect)	**SP** (Surge Protection) • 30kA/600VDC Interrupting Rating • IP20 finger-safe construction • Small size takes up minimal space in enclosure (Only 2 inches wide) **BLANK** (No surge protection)	**DCM** Pre-installed DC current monitoring unit (qty 1 per 8 strings) **BLANK** (No DC current monitoring)	**1000V** (1000V) **BLANK** (600V)

*Combiners with 37-48 input circuits are not third party certified, but are constructed to UL 1741 standards
†UL98B Listed Disconnect Switch 1000V

Solar Recombiners

Cooper Crouse-Hinds Recombiner boxes are used in larger photovoltaic systems. A Recombiner box effectively groups the output wires from several combiner boxes into one main output feed which then goes to the inverter, saving labor and material costs

Application:

In large photovoltaic (PV) systems, multiple combiner boxes are often necessary, and the outputs of these combiner boxes may need to be combined again—recombined—before reaching a central inverter. Cooper Crouse-Hinds Recombiner Boxes allow for ease of installation, saving time, labor, and most importantly, system costs. Solar Recombiners range from 2 to 12 input circuits, with a durable non-metallic (NEMA 4X) or metallic (NEMA 3R) painted steel enclosure.

Features:

- Rated for 600 VDC or 1000VDC - continuous duty
- 2 -12 input circuits
- Installed fuses included
- Lexan shield covers all live components
- 90ºC output terminals
- NEMA 4X Fiberglass enclosures with captive stainless steel screws and formed-in-place polyurethane seamless gasket provided as standard
- Also available in NEMA 3R painted steel, NEMA 4 powder coated steel or NEMA 4X stainless steel
- Configured for positive and negative grounded arrays

Certification and Compliances:

- Constructed to UL 1741 Standards
- NEMA 4X (fiberglass)
- NEMA 4 (powder coated steel)
- NEMA 3R (painted steel)
- Made in America

Options:

- Surge protection
- NEMA 3R Painted Steel
- NEMA 4 Powder Coated Steel
- NEMA 4X Stainless Steel
- Smart recombiners available (DC string monitoring)
- Factory drilled entrance holes
- Factory installed connectors
- Custom options available - Consult factory

Catalog Numbering System

Use the table below to build a catalog number for a combiner configuration that matches your specific project requirement

BASE SOLAR RECOMBINER		WITH OPTIONAL FACTORY SUPPLIED FUSES	W/OPTIONAL SURGE PROTECTION	DC MONITORING	VOLTAGE
CRBF	02	F100			
Enclosure Type	**Number of Input Circuits**	**Fuse Amperage**	**Surge Protection**	**DC Monitoring**	**Voltage**
CRBF (Fiberglass N4X) **CRBS** (Painted Steel N3R) **CRBSS** (Stainless Steel N4X) **CRB4S** (Powder Coated Steel N4)	**02** (2 input circuit) **03** (3 input circuit) **04** (4 input circuit) Consult factory for available configurations greater than 4 input circuits (up to 12 circuits available)	**F60** (60A fuse) **F70** (70A fuse) **F80** (80A fuse)* **F100** (100A fuse) **F125** (125A fuse) **F150** (150A fuse) **F160** (160A fuse)* **F175** (175A fuse) **F200** (200A fuse) Consult factory fuse sizing above 200A *1000V Only • Cooper Bussmann fuses recommended	**SP** (Surge Protection) • 30kA/600VDC Interrupting Rating • IP20 finger-safe construction • Small size takes up minimal space in enclosure (Only 2 inches wide) **BLANK** (No surge protection)	**DCM** Pre-installed DC current monitoring units **BLANK** (No DC current monitoring)	**1000V** (1000V) **BLANK** (600V)

Wire Size & Torque Table

<table>
<tr><th rowspan="3">Strings</th><th colspan="2">Positive Input Terminal</th><th colspan="2">Negative & Ground Input</th><th colspan="2">Positive Output Terminal</th><th colspan="2">Negative Output Teminal</th><th colspan="2">Ground Output Terminal</th><th>Bolted Connections</th></tr>
<tr><th>Wire Size (AWG/kcmil)</th><th>Torque (in-lbs)</th><th>Wire Size (AWG/kcmil)</th><th>Torque (in-lbs)</th><th>Wire Size (AWG/kcmil)</th><th>Torque (in-lbs)</th><th>Wire Size (AWG/kcmil)</th><th>Torque (in-lbs)</th><th>Wire Size (AWG/kcmil)</th><th>Torque (in-lbs)</th><th>Torque (in-lbs)</th></tr>
<tr><td>01</td><td rowspan="12">#16-#8</td><td rowspan="12">20-25</td><td rowspan="36">#14-#4</td><td rowspan="36">20-35</td><td rowspan="6">#4-350
#10-1/0**</td><td rowspan="6">110-325
20-35**</td><td rowspan="6">#4-350
#8-2/0**</td><td rowspan="6">110-325
120-500**</td><td rowspan="36">#14 -250</td><td rowspan="36">110-325</td><td rowspan="24">80
275‡</td></tr>
<tr><td>02</td></tr>
<tr><td>03</td></tr>
<tr><td>04</td></tr>
<tr><td>05</td></tr>
<tr><td>06</td></tr>
<tr><td>07</td><td>#3-350</td><td rowspan="3">150-325</td><td>#3-350</td><td rowspan="3">150-325</td></tr>
<tr><td>08</td><td>#2-350</td><td>#2-350</td></tr>
<tr><td>09</td><td>#1-350</td><td>#1-350</td></tr>
<tr><td>10</td><td rowspan="15">#18-#8</td><td rowspan="15">20-25</td><td>1/0-350</td><td rowspan="5">180-325</td><td>1/0-350</td><td rowspan="5">180-325</td></tr>
<tr><td>11</td><td>1/0-350</td><td>1/0-350</td></tr>
<tr><td>12</td><td>2/0-350</td><td>2/0-350</td></tr>
<tr><td>13</td><td>1/0-350</td><td>1/0-350</td></tr>
<tr><td>14</td><td>2/0-350</td><td>2/0-350</td></tr>
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<tr><td>16</td></tr>
<tr><td>17</td><td>2/0-350</td><td>180-325</td><td>2/0-350</td><td>180-325</td></tr>
<tr><td>18</td><td rowspan="6">3/0-350</td><td rowspan="6">250-325</td><td rowspan="6">3/0-350</td><td rowspan="6">250-325</td></tr>
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<tr><td>24</td><td>4/0-350</td><td>4/0-350</td></tr>
<tr><td>25</td><td rowspan="12">4/0 - 500</td><td rowspan="12">250-375</td><td rowspan="12">4/0 - 500</td><td rowspan="12">250-375</td><td rowspan="12">80
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<tr><td>34</td></tr>
<tr><td>35</td></tr>
<tr><td>36</td></tr>
</table>

Note: '**' Indicates Sizing for Models with No Integral Disconnect Switch
"‡" Indicated Torque values for accessories of the Disconnect Switch including jumpers and lugs

Standard Enclosure Sizing

	String Count	NEMA Type	Size
Base Models	1-6	4X	12X10X05
		3R	12X10X06
	7-12	4X	16X14X06
		3R	16X16X06
	13-20	4X	18X16X08
		3R	18X18X06
	21-24	4X	20X16X08
		3R	20X16X06
	25-36	4X	36X30X12
		3R	36X30X12
With Disconnect Switch	1-15	4X	18X16X08
		3R	18X18X10
	16-19	4X	20X16X08
		3R	24X24X10
	20-24	4X	24X24X10
		3R	24X24X10
	25-36	4X	36X30X12
		3R	36X30X12
With DC Monitoring	1-8	4X	20X16X08
		3R	24X20X08
	9-16	4X	30X24X10
		3R	30X24X08
	17-24	4X	36X30X12
		3R	36X30X12
	25-36	4X	36X30X12
		3R	36X30X12
1000V with Disconnect Switch	1-6	4X	12X10X05
		3R	12X10X05
	7-12	4X	24X20X08
		3R	24X20X08
	13-24	4X	30X30X12
		3R	30X30X12
	25-36	4X	36X30X12
		3R	36X30X12

* Not all configurations and enclosure types are listed above, customer specifications and construction requirements impact sizing

Electrical Properties (600Vdc)

	Catalog number (i.e. CCBF12)		Maximum Input Fuse Rating	Maximum Continuous Operating Current	Maximum Input Short Circuit Current (Isc)	Maximum Voltage
	Base	String Input	(A)	(A)	(A)	(VDC)
1 Through 12 String	CCBF_ CCBS_	01	30	100	13.20	600
	CCBF_ CCBS_	02	30	100	13.20	
	CCBF_ CCBS_	03	30	100	13.20	
	CCBF_ CCBS_	04	30	100	13.20	
	CCBF_ CCBS_	05	30	100	13.20	
	CCBF_ CCBS_	06	30	100	13.20	
	CCBF_ CCBS_	07	30	100	13.20	
	CCBF_ CCBS_	08	30	100	13.20	
	CCBF_ CCBS_	09	30	200	13.20	
	CCBF_ CCBS_	10	30	200	13.20	
	CCBF_ CCBS_	11	30	200	13.20	
	CCBF_ CCBS_	12	30	200	13.20	
12 Through 24 String	CCBF_ CCBS_	13	30	200	8.80	600
	CCBF_ CCBS_	14	30	200	8.80	
	CCBF_ CCBS_	15	30	200	8.80	
	CCBF_ CCBS_	16	30	200	8.80	
	CCBF_ CCBS_	17	30	200	8.80	
	CCBF_ CCBS_	18	30	200	8.80	
	CCBF_ CCBS_	19	30	250	8.80	
	CCBF_ CCBS_	20	30	250	8.80	
	CCBF_ CCBS_	21	30	250	8.80	
	CCBF_ CCBS_	22	30	250	8.80	
	CCBF_ CCBS_	23	30	400	8.80	
	CCBF_ CCBS_	24	30	400	8.80	
25 Through 36 String	CCBF_ CCBS_	25	30	400	7.60	600
	CCBF_ CCBS_	26	30	400	7.60	
	CCBF_ CCBS_	27	30	400	7.60	
	CCBF_ CCBS_	28	30	400	7.60	
	CCBF_ CCBS_	29	30	400	7.60	
	CCBF_ CCBS_	30	30	400	7.60	
	CCBF_ CCBS_	31	30	400	7.60	
	CCBF_ CCBS_	32	30	400	7.60	
	CCBF_ CCBS_	33	30	400	7.60	
	CCBF_ CCBS_	34	30	400	7.60	
	CCBF_ CCBS_	35	30	400	7.60	
	CCBF_ CCBS_	36	30	400	7.60	

Electrical Properties (1000Vdc)

	Catalog number (i.e. CCBF12)		Maximum Input Fuse Rating	Maximum Continuous Operating Current	Maximum Input Short Circuit Current (Isc)	Maximum Voltage
	Base	String Input	(A)	(A)	(A)	(VDC)
1 Through 12 String	CCBF_ CCBS_	01	20	100	8.80	1000
	CCBF_ CCBS_	02	20	100	8.80	
	CCBF_ CCBS_	03	20	100	8.80	
	CCBF_ CCBS_	04	20	100	8.80	
	CCBF_ CCBS_	05	20	100	8.80	
	CCBF_ CCBS_	06	20	100	8.80	
	CCBF_ CCBS_	07	20	100	8.80	
	CCBF_ CCBS_	08	20	100	8.80	
	CCBF_ CCBS_	09	20	100	8.80	
	CCBF_ CCBS_	10	20	200	8.80	
	CCBF_ CCBS_	11	20	200	8.80	
	CCBF_ CCBS_	12	20	200	8.80	
12 Through 24 String	CCBF_ CCBS_	13	20	200	8.80	1000
	CCBF_ CCBS_	14	20	200	8.80	
	CCBF_ CCBS_	15	20	200	8.80	
	CCBF_ CCBS_	16	20	200	8.80	
	CCBF_ CCBS_	17	20	200	8.80	
	CCBF_ CCBS_	18	20	200	8.80	
	CCBF_ CCBS_	19	20	250	8.80	
	CCBF_ CCBS_	20	20	250	8.80	
	CCBF_ CCBS_	21	20	250	8.80	
	CCBF_ CCBS_	22	20	250	8.80	
	CCBF_ CCBS_	23	20	400	8.80	
	CCBF_ CCBS_	24	20	400	8.80	
25 Through 36 String	CCBF_ CCBS_	25	20	400	6.40	1000
	CCBF_ CCBS_	26	20	400	6.40	
	CCBF_ CCBS_	27	20	400	6.40	
	CCBF_ CCBS_	28	20	400	6.40	
	CCBF_ CCBS_	29	20	400	6.40	
	CCBF_ CCBS_	30	20	400	6.40	
	CCBF_ CCBS_	31	20	400	6.40	
	CCBF_ CCBS_	32	20	400	6.40	
	CCBF_ CCBS_	33	20	400	6.40	
	CCBF_ CCBS_	34	20	400	6.40	
	CCBF_ CCBS_	35	20	400	6.40	
	CCBF_ CCBS_	36	20	400	6.40	

*Note: PV-20 fuse is to be used for max 900V systems
Ratings vary based on input fuse size
Ratings vary based on construction

Overcurrent Protection - PV Fuse-Links

Current Rating	Energy Integrals (A2s)		Power Loss (watts)	
	Pre-Arcing	Total at 1000V	0.8 In	In.
8A	3	32	0.5	2.0
10A	7	50	0.6	2.1
12A	10	100	1.3	2.6
15A	20	200	1.8	3.0

For more information:

If further assistance is required, please contact an authorized Cooper Crouse-Hinds Distributor, Sales Office, or Customer Service Department

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COOPER Crouse-Hinds

ADVANCED ENERGY®

AE 75TX and AE 100TX

(Formerly known as PVP75kW and PVP100kW)

The industry standard for reliability and ease of installation

The AE 75TX and AE 100TX commercial inverters set the industry standard for high reliability, ease of installation, and lifetime maintainability. Designed for a 20+ year operating life, high reliability is enabled by busbar power connections, redundant cooling system, and card cage circuit board design resulting in a track record of 99+% uptime. With a best-in-class efficiency of 96%, the highly integrated system is designed to save installers time and money with load break rated AC & DC service disconnects, neutral-free installation, oversized busbar landings, and generous cable bending area with bottom and side entry options. The wide 295-595 V operating window maximizes energy harvest and provides exceptional stringing flexibility.

New features include remote disable inputs and an expanded array of monitored subcombiner fusing options. A 24 V auxiliary power supply, revenue grade meter, and performance monitoring gateway can also be added for a completely integrated inverter solution. Advanced power controls provide essential utility support functions including power factor, curtailment, and controlled ramp rate.

The AE 75TX and the AE 100TX are backed with an industry-leading 10-year nationwide warranty and a comprehensive optional 20-year warranty; plus the best service and support team in the business.

Superior Reliability

- Engineered power connections eliminate failure points
- Increased availability with >99% monitored fleet availability
- Card cage circuit board design
- Redundant cooling system with Smart Air Management™
- Redundant industrial grade power supply

Exceptional Installability

- Bottom and side cable entry
- Generous cable bending area
- Complete range of fused DC subcombiner options
- Exterior mounting flange for fast and easy anchoring
- Error-free AC auto-phasing

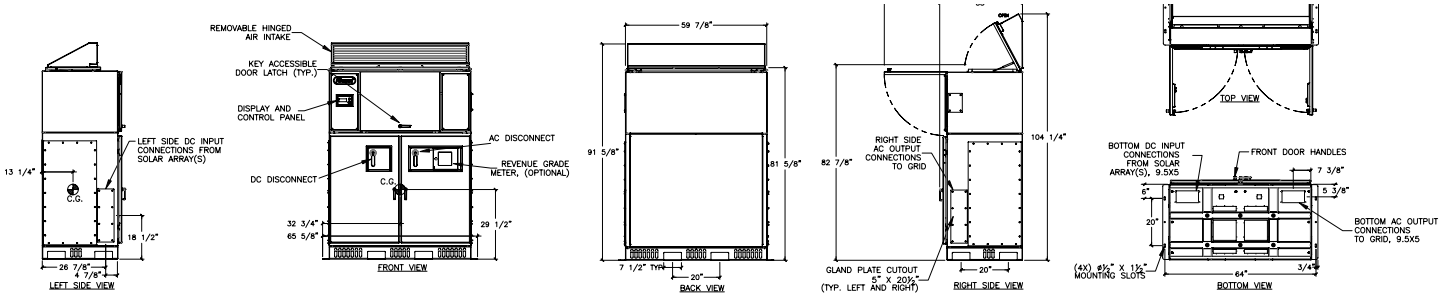
Easy to Maintain

- All maintenance and service via front and side access
- Fast change circuit board system shortens service time
- Load break rated AC and DC service disconnects
- Dedicated performance monitoring section

AE Solar Energy is a US based company.

ONTARIO FEED IN TARIFF
DOMESTIC CONTENT COMPLIANT

Dimensions - AE 75TX and AE 100TX


LEFT SIDE VIEW
FRONT VIEW
BACK VIEW
RIGHT SIDE VIEW
TOP VIEW
BOTTOM VIEW
REMOVABLE HINGED AIR INTAKE
KEY ACCESSIBLE DOOR LATCH (TYP.)
DISPLAY AND CONTROL PANEL
AC DISCONNECT
DC DISCONNECT
REVENUE GRADE METER, (OPTIONAL)
LEFT SIDE DC INPUT CONNECTIONS FROM SOLAR ARRAY(S)
RIGHT SIDE AC OUTPUT CONNECTIONS TO GRID
GLAND PLATE CUTOUT 5" X 20½" (TYP. LEFT AND RIGHT)
BOTTOM DC INPUT CONNECTIONS FROM SOLAR ARRAY(S), 9.5X5
FRONT DOOR HANDLES
BOTTOM AC OUTPUT CONNECTIONS TO GRID, 9.5X5
(4X) 6¾" X 1½" MOUNTING SLOTS

AE 75TX and AE 100TX Summary Specifications*

Mechanical	AE 75TX	AE 100TX
Weight	2750 lbs	3000 lbs
Construction	Powder coated steel, optional stainless steel	Powder coated steel, optional stainless steel
Environmental Rating	NEMA 4	NEMA 4
Mounting	Pad Mount	Pad Mount
Isolation Transformer	Integrated	Integrated
Integrated AC/DC Disconnect	Included	Included
AC and DC Surge Protection	Included	Included
Electrical		
DC Inputs		
Array Configuration	Positive or negative ground	Positive or negative ground
Maximum Operating Input Current	267A	356 A
Maximum DC Input Voltage (VOC)	600 V	600 V
MPPT Voltage Range	295-595 V	295-595 V
Open-Circuit Turn-On Voltage	330 V	330 V
AC Output		
Continuous Output Power (kW)	75 kW	100 kW
Nominal Voltage	208 Y, 480 Y, 600 Y	208 Y, 480 Y, 600 Y
Operating Voltage Range	-12% / +10%	-12% / +10%
Electrical Service Compatibility	3 phase, 4 wire, grounded Wye	3 phase, 4 wire, grounded Wye
Maximum Continuous Current	208: 208 A 480: 91 A 600: 72 A	208: 278 A 480: 120 A 600: 96 A
Short Circuit Fault Current	208: 320 Arms @ 208 VAC, 60.3 ms 480: 139 Arms @ 480 VAC, 60.3 ms 600: 111 Arms @ 600 VAC, 60.3 ms	208: 320 Arms @ 208 VAC, 60.3 ms 480: 139 Arms @ 480 VAC, 60.3 ms 600: 111 Arms @ 600 VAC, 60.3 ms
Nominal Frequency	60 Hz	60 Hz
Frequency Range	59.3 - 60.5 Hz, adjustable to 57.0 Hz	59.3 - 60.5 Hz, adjustable to 57.0 Hz
Total Harmonic Distortion	< 3% THD	< 3% THD
Efficiency		
Efficiency: Peak/CEC	208: 96.1% / 95.5% 480: 96.6% / 95.5% 600: 96.5% / 96.0%	208: 96.4% / 95.5% 480: 97.1% / 96.0% 600: 96.4% / 96.0%
Standby Losses	< 42 W	< 42 W
Inverter Controls and Monitoring		
Power Factor	> 0.99, adjustable to 0.9 leading or lagging	> 0.99, adjustable to 0.9 leading or lagging
Power Curtailment	5 - 100%, 1% increments	5 - 100%, 1% increments
Communication Interfaces and Protocols	RS-485, Ethernet, Modbus, TCP/IP	RS-485, Ethernet, Modbus, TCP/IP
Environmental		
Operating Ambient Temp. Range	-30 °C to 50 °C	-30 °C to 50 °C
Standby/Storage Ambient Temp. Range	-40 °C to 60 °C	-40 °C to 60 °C
Cooling	Forced Convection	Forced Convection
Relative Humidity	0 to 95%, non-condensing	0 to 95%, non-condensing
Elevation	6000 ft	6000 ft
Noise Emission	< 61 dBA, typical at full load	< 61 dBA, typical at full load
Regulatory		
Agency Approvals / Regulatory Compliance	UL 1741, IEEE 519, IEEE 929, IEEE 1547, CSA 107.1-1, FCC Class A	UL 1741, IEEE 519, IEEE 929, IEEE 1547, CSA 107.1-1, FCC Class A
Inverter Warranty	10 Year	10 Year

Subject to change without notice. Refer to user manual for detailed specification.
*Note: Not all performance window specifications can be achieved simultaneously. Performance varies per site.
Consult your AE sales or service representatives for specific PV system design questions at sales.support@aei.com.

Advanced Power Controls

- Power factor
- Curtailment
- Controlled ramp rate
- Remote enable/disable

Options

- Integrated fused subcombiner: up to 9 inputs of 70 A - 600 A (max total of 675 A)
- Integrated fused subcombiner with monitoring: Up to 6 inputs of 70 A - 100 A or up to 5 inputs of 70 A - 200 A (max total of 675 A)
- Integrated revenue grade meter
- Integrated data monitoring
- 24 V auxiliary power supply
- Stainless steel
- 20-year extended warranty

Performance Monitoring

Increase uptime and reduce maintenance costs with integrated performance monitoring hardware that enables connectivity to a variety of software solutions from industry leading monitoring partners. The tight integration between Advanced Energy and our monitoring partners creates a superior service and support experience while seamlessly delivering meaningful data. Factory integration and testing of our UL listed monitoring solution ensures high reliability and significantly reduces field installation costs.

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